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CAR-FERRY STEAMER "DETROIT"; MICHIGAN CENTRAL R. R.

A four-screw car-ferry steamer of exceptional size and power, designed to serve as an ice-breaker and maintain communication through the heaviest ice, has been built for the Detroit River service of the Michigan Central Ry. (between Detroit, Mich., and Windsor, Ont.). The railway company has four car-ferry steamers, and all but the new one are propelled by side wheels. The distance across the river is half a mile, and the time allowed for crossing is 10 to 12 minutes, including landing. The new steamer, Fig. 1, has been in service through the latter part of the winter, and in January performed successful work in contending with very heavy ice and ice jams. It was built by the Great Lakes Engineering Works, of Detroit, Mich., and we are indebted to the builders for photographs and other information.

The "Detroit" is 308 ft. long, 64 ft. beam of hull, and 76 ft. beam over the guards, with a molded depth of 19 ft. 6 ins. and a displacement of 3,850 tons. Its average speed is 18 miles an hour. The draft is 10 ft. light and 14 ft. loaded. The engines and boilers are placed below the deck, from which rise four smokestacks. On each side is a deck house about 90 ft. long, with accommodation for the officers and crew (34 in summer and 55 in winter), and for the American and Canadian customs officers, as well as special quarters for the superintendent and superintending engineer of the railway company's marine department. The top of each deck house forms a promenade deck. There are three tracks, the two outer tracks being spread so as to clear the smokestacks, and the vessel can carry 24 freight cars or 12 Pullman cars. The cars are secured to the tracks with clamps and chains. The vessel has rudders and screws at both ends, for use in manœuvring, but it is not double-ended; one end is normally the bow and has a high steel bridge spanning the tracks and carrying the pilot house. At each side of the river the boat is run with its bow against a pier or slip having three tracks.

There are four compound engines of the marine type, with cylinders 24 × 33 and 48 × 33 ins. The crank shafts are 10¾ ins. diameter, of the built-up type and with counterbalanced cranks; the crank pins are 10 × 10 ins., and all crank pins and journals are finished by grinding. The thrust shafts are 11 ins. diameter; line shafts, 10½ ins.; tube and tail shafts, 11¼ ins. (11¾ ins. at the bearings). the tail shafts have taper fits for the four-bladed screw propellers, 10 ft. 6 ins. diameter and 14 ft. 6 ins. pitch. The four levers in the pilot house for the engine-room tell-tales have each a push button in the handle which rings a bell in the engine room, and a lamp in front of the pilot is connected with the bell circuit so as to show when this circuit is closed and the bell is ringing. In front of the pilot are four pairs of small red and green lamps, one pair for each engine. When an engine is working ahead the green lamp shows a light, while the red lamp is burning when the engine is reversed. In this way the pilot can see at a glance what engines are working and in which direction.

There are two twin vertical compound air pumps, and duplicate compound boiler-feed pumps. As the vessel may stay in the slip for several hours, and the hot-well supply is then cut off by the stoppage of the air pumps, a special feed system is used. Two of the air pumps discharge into the bottom of a large feed tank, from which the water is pumped into an open Cochrane heater connected to the suction pipes of the feed pumps. The tank pump and feed pumps are fitted with pressure governors, and the feed-water supply is controlled entirely by the feed valves at the boilers. When the feed pumps are stopped, the water rises in the heater and by means of a float closes a valve in the delivery pipe of the tank pump, which pump is then shut down by its governor. The exhaust steam from the engines of the pumps, dynamos, fans and steering gear is passed through a separator and thence to the feed-water heater. Two direct-connected dynamos supply current for the lighting system, including a large searchlight.

Steam is supplied by four Scotch boilers; they are built for 150 lbs. pressure, but except when the vessel is working in the ice the working pressure is 100 lbs. Forced draft on the closed ash-pit system is provided in case of necessity. There are four oblong smokestacks rising 35 ft. above the deck and surrounded to a height of 14 ft. by casings which serve as ventilating trunks for the fire rooms. The bunkers carry 300 tons of coal and are supplied by hopper bottom cars standing on the outer tracks over deck openings 40 ft. long.

The steel hull is very heavily built, as shown by Figs. 2 and 3, but the keel is straight from end to end instead of being curved upward as in most ice-breaking steamers. The vessel is therefore designed to cut and drive a way through the ice instead of riding upon it and breaking it by the weight of the vessel. The frames are steel channels 10 × 3⅜ ins., spaced 24 ins. Four lines of box girders carry the engine frames. The deck beams are 15-in. channels, with a camber of 6 ins. in 64 ft.; these are spaced 4 ft. c. to c., and are supported by three rows of columns, each composed of a pair of steel channels. Diagonals extend from the tops of the outer columns to the sides of the hull. The deck projecting beyond the hull is supported by 9-in. channels with angle-iron struts to the hull. Around the edge of the deck is a continuous 12-in. channel carrying an oak fender timber 6 × 12 ins., faced with a steel

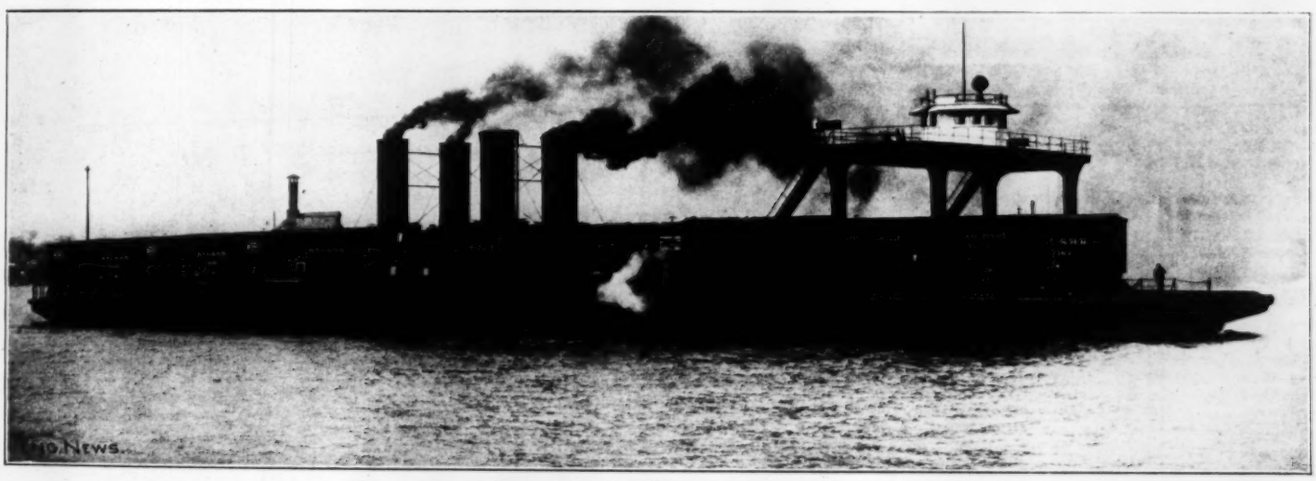


FIG. 1. CAR-FERRY STEAMER "DETROIT," MICHIGAN CENTRAL RY.
Great Lakes Engineering Works, Detroit, Mich.; Builders.

plate 1 × 9 ins. The 80-lb. track rails are carried by girders of I-section built up of four angles, the vertical legs of the upper angles being between those of the lower angles.

Fig. 4 is an end view, looking towards the stern, aand shows the pilot house and tracks.

THE USE OF CONCRETE IN AN ELECTRIC POWER STATION.*

By Eugene B. Clark,† M. Am. Inst. E. E.

The Illinois Steel Company has just completed and placed in operation at its plant in South Chicago, a new power-house for the supply of power to its various mills at South Chicago, and at Buffington, ten miles distant. This station contains, at the present time, two units, each consisting of a 2,000 KW., 25-cycle, 2,200-volt, three-phase generator, direct driven by a 24-in. by 60-in. by 48-in. horizontal-vertical cross-compound engine. The addition of two more generating units, of a capacity of 4,000-KW. each, is contemplated in the near future. This alternating-current station operates in conjunction with a direct-current station which has been in service for some time. The two power houses are connected by means of synchronous converters. Both stations take steam from blast-furnace boiler-houses, in which the fuel is excess blast-furnace gas. The supply of this excess gas is quite variable at times, and it is desirable under such conditions to be able to shift load from one station to the other, as desired. Such an arrangement gives the opportunity of utilizing completely all excess blast-furnace gas at either point.

The point of interest at present is the use of cement in the building of this and other power houses.

FOUNDATIONS.—The foundations for the machinery and the building rest upon piles and are made of slag concrete, consisting of one part cement, three parts torpedo sand, and seven parts crushed slag. The cement used for those parts of the foundations which are not exposed was of the brand known as "Puzzolan"; for those parts which are exposed, "Universal" Portland cement was used. The foundations were started in the coldest weather of last winter, and the concrete, which had to be mixed with warm water and warm sand, to keep from freezing in the mixer, did freeze immediately after being tamped into place. Filling was used to follow up the foundations as rapidly as they were put in place, so that the concrete was not permitted alternately to freeze and thaw as the warmer weather came on. The result was to obtain a thoroughly solid foundation, the concrete setting up firmly as it gradually thawed during the spring months. About the middle of summer the foundation was tested by drilling a hole several feet deep into that part which had originally been frozen. It was found that it had set up to make an extremely solid and strong concrete.

FLOORS.—A considerable amount of time and attention was devoted to determining the most desirable method of floor construction. The power house apparatus is controlled by electrically-operated switching devices. The electrically-operated switches, together with the bus-bars, control-pedestals, instrument-posts and feeder-panels, required for their accommodation the construction of galleries at one end of the engine room. Two of these galleries were built, and the engine room floor was used as another gallery. On the engine room floor were located the generator switches; on the first gallery were located the bus-bars, the instrument posts, generator control pedestals, feeder panels, etc.; on the third gallery were located the feeder switches and the lightning arresters. A transmission line, carrying a pressure of 20,000 volts, was necessary to transmit the required amount of power to Buffington, located 10 miles south of South Chicago.

At least 4,500 KW. of transformers had to be located in the power house. It was decided to place these on the engine room floor, under the first gallery, constructing an isolated transformer room for that purpose. The transformer room was isolated from the rest of the apparatus on the engine room floor by means of a wall about 3 ins. thick and 17 ft. high, built of reinforced concrete, in accordance with the method to be described later. This wall proved, after erection, to be thoroughly solid and substantial; as rigid, in fact, as would have been a masonry wall 12 or 14 ins. thick.

It then became necessary to take wires carrying a pressure of 20,000 volts through the operator's position on the first gallery. In order to harmonize these various requirements, it soon became evident that much additional space would be required if it should prove necessary to have the usual steel beams in the gallery floors, inasmuch as the beams would be in the way of the many wires which it would be necessary to take through these floors. These conditions pointed to the advisability of using a floor construction of concrete slabs or of fireproof tile. Careful consideration of the subject proved that even with the comparatively long spans for such heavy loads the concrete construction would be far preferable, both from the standpoint of cost and from the standpoint of fireproofing. Experience at the Baltimore fire had shown that properly constructed concrete floors had withstood the test of fire and water better than any other kind of floors.

To make certain of the safety and conservatism of the proposed design, a section of the floor, as proposed, was built and tested prior to the final decision as to the construction of the floor for the building and galleries. After being allowed to set 21 days, this section of floor was tested by piling pig iron upon it, to the extent of 500 lbs. per sq. ft. The test slab was 7 ins. thick and 15 ft. in span, made of concrete consisting of one part "Universal" cement, two parts torpedo sand, and four parts 0.5 to 1-in. crushed limestone, reinforced with 0.5-in. steel rods, spaced 5 ins. apart and laid on top of No. 10 gage expanded metal placed 1 in. from the bottom of the slab. Upon test, the slab collapsed under a load of 550 lbs. per sq. ft. An even distribution of the load over the surface was obtained by covering the top of the slab with about 4 ins. of sand, upon which was piled the pig iron. Deflections were measured as the load increased. The deflection at the center had risen to about 1.5 ins. by the time the slab failed. It was determined that the expanded metal was comparatively valueless for purposes of reinforcement when used in conjunction with the 0.5-in. round rods, as all the tension was taken by the rods. These rods were bent at the ends for a distance of about 10 or 12 ins. through an angle of 180°, thereby insuring that

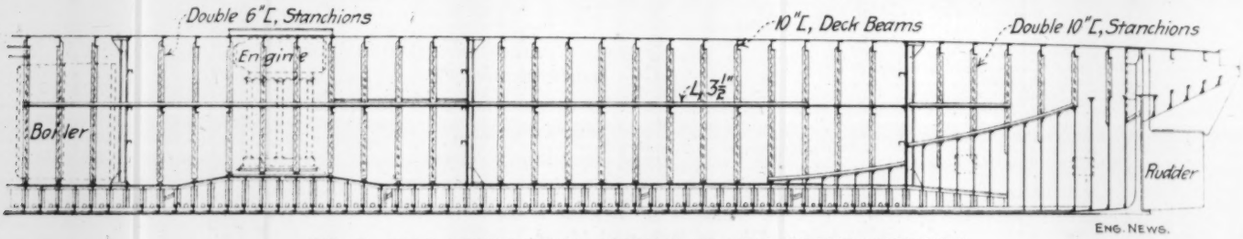


FIG. 2. HALF LONGITUDINAL SECTION OF HULL OF THE "DETROIT."

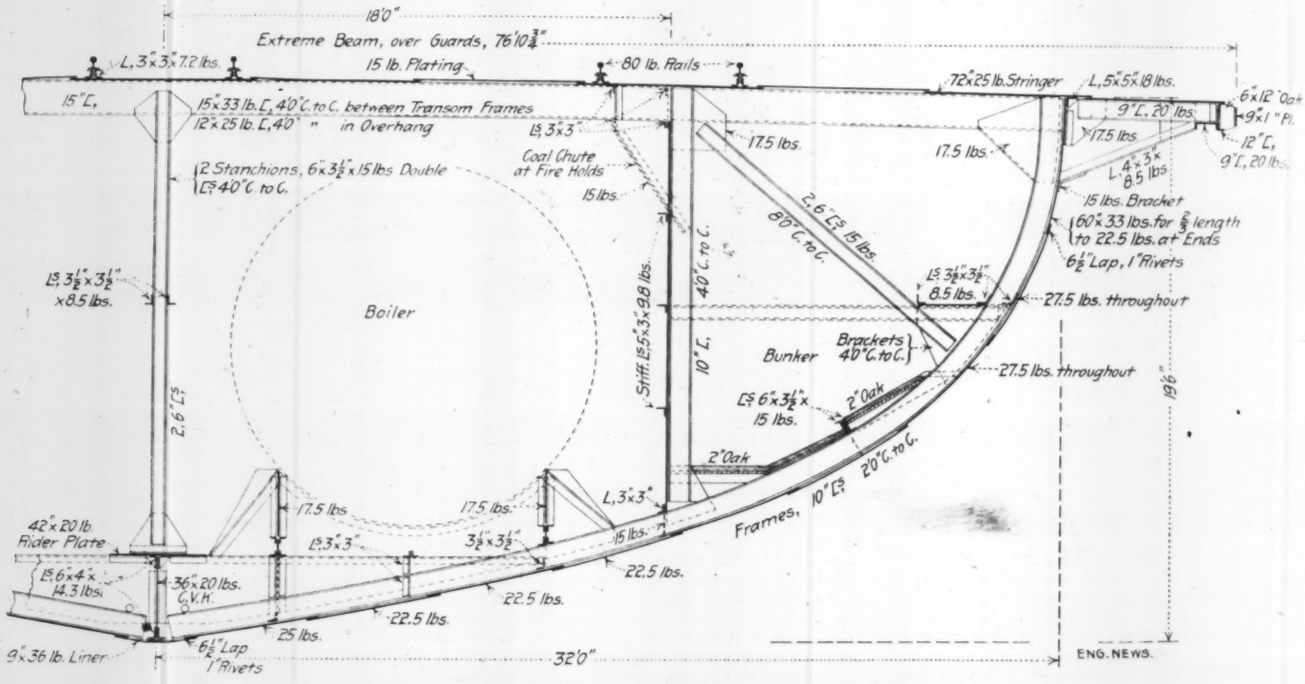


FIG. 3. HALF CROSS-SECTION OF "DETROIT" AT BOILER ROOM.

*A paper read before the Chicago Branch of the American Institute of Electrical Engineers, Feb. 28, 1905.

†Electrical Engineer, Illinois Steel Co., Chicago, Ill.

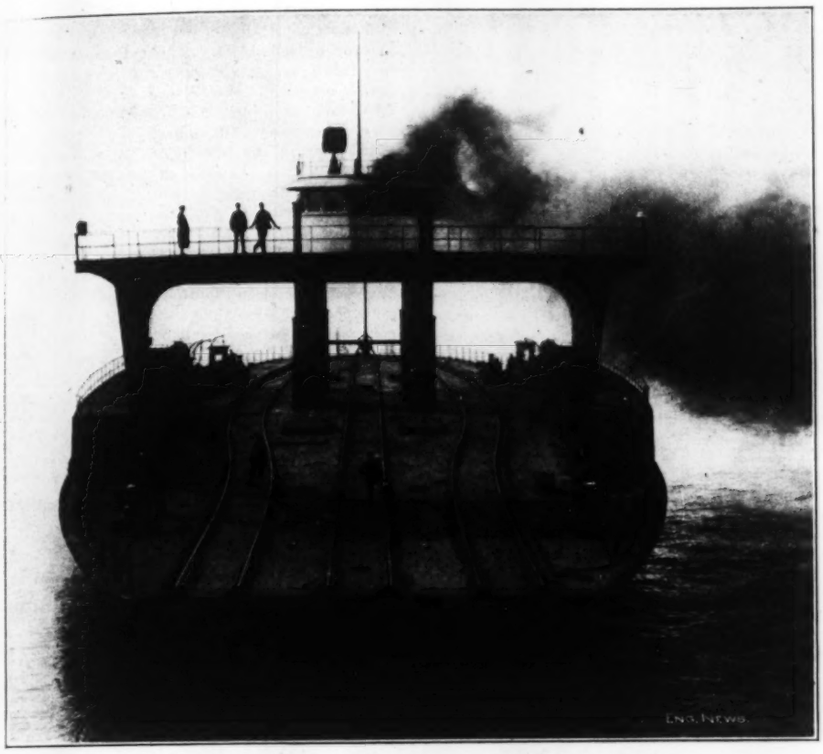


FIG. 4. END VIEW OF THE CAR-FERRY STEAMER "DETROIT."

they would not pull out at these points. It was found necessary to bend the rod through 180°, and not through 90°; for those which were bent only 90° showed a very decided tendency to crack the concrete at the corners and then to pull out. Round rods were used in preference to twisted or notched or any other form of rods designed to prevent slipping or pulling out of concrete, and for two reasons: first, the round rods are far cheaper; second, it was decided that nothing was gained by preventing the rods from pulling out of the concrete, provided they were properly fastened at each end.

The mixture used in all the floor construction was one part "Universal" Portland cement, two parts torpedo sand, and four parts crushed limestone, 0.5 to 1-in. size. The shoring under all floors was permitted to remain 28 days before removal. In the engine room floor, for the very long spans, some floor beams were used, but in all cases they were entirely covered with concrete, to give thorough fireproofing. Wherever generator-pits or fly-wheel pits were to be covered, such covers were made of cement castings reinforced with expanded metal, rather than of cast iron. These cover plates were made to exact fit for each place as the work progressed, no drawings being necessary. The carpenter made a small mold of the correct size, in which the cement worker cast his floor plate and finished it exactly as the rest of the floor. The gallery floors were completed and the shoring removed before any work was done on the installation of the electrical control apparatus or the supports therefor. Each gallery was treated as independent of the one under it, so far as support was concerned, though, in building up the switch cells, the bus-bar construction, and the barriers, the practical result was to give additional support to each floor from the one under it. The switch structure was also constructed in such a way as practically to be a beam in itself. Round iron rods were cast into the lower part of the structure and allowed to extend through from the first switch in the row to the last. The result was to provide a construction of the switch cells which, being in itself a beam, would distribute the load to those points where the load might best be taken. In addition to this fact, the barrier which rose from the switch cell to the ceiling above, taken in conjunction with the lateral barriers —all of which were built monolithic with the wall rising from the switch structure—formed a column of great strength. It would probably not be poor engineering to depend, in a measure, upon the strength of this column to support the floor above it; but in the case which is being described this was not done. Even though no attempt was made to utilize the switch structure as a column, still, the fact was taken into consideration that there would be a natural tendency, by reason of the presence of the switch structure, to transmit load from one floor to the one under it, and therefore to impose a greater load upon the lower floor than would be accounted for by the weight actually upon that floor. This effect was compensated for by giving the lowest floor additional supporting columns, which were placed between the basement and engine room floor. These columns were covered with expanded metal and a cement plaster to insure against failure, in case a fire should occur, due to the storing of inflammable materials. It had not been contemplated that such materials should be stored in the basement, but it was thought wise to provide against this contingency.

ROOF.—The roof of the engine house was constructed of concrete laid in place as is usual for sidewalks. In each bay a removable wooden frame was secured to the top chords of the steel roof trusses in such a way as to permit of ready removal by knocking out wedges after the roof was in place. A thin layer of cement mortar, consisting of cement and sand, was placed on the top of this woodwork support. The function of this thin layer was to give a smooth coat for the finished interior of the roof. The expanded metal reinforcement was laid immediately on top of this preliminary coat, and was covered with about two inches of concrete of about the same mixture as was used for the floors. On top of this was placed a thin layer of rich mixture, which was given a sidewalk finish on the side exposed to the weather. After 28 days, the wooden supports were removed from the inside by knocking out wedges, and were lowered to the engine room floor. The roof, made in this way, developed cracks after drying out. These cracks were filled by pouring into them a thin grout consisting of cement and sand. The result was to stop all leaks and insure a roof which was cheap and thoroughly fireproof. It has the disadvantage of being heavy and requires rather heavier roof trusses than does a tile or slate roof; it is very strong and is not damaged by men walking upon it, or by falling pieces of stone or other materials. The latter consideration is an important one in the case described, because the station is located near blast furnaces, which, unfortunately, have the habit of throwing stone and ore out of the top at times. The advantage of using expanded metal on such a place as a roof, rested entirely in the economy of labor in handling the material. The writer believes the disposition of material in expanded metal to be uneconomical and, at times, disadvantageous. All of that material which lies transversely to the strain is wasted, and, furthermore, it is the speaker's belief that there is a tendency on the part of expanded metal, when subjected to strain, to elongate the diamond-shaped meshes and to shear off the concrete between the meshes. The tendency to shear the concrete would be trifling and unimportant if, in addition to this, there were not a tendency to break the concrete which is always placed below the expanded metal for fireproofing purposes. This lower section of concrete is generally about 1 in. thick; being in tension, it is apt to crack when the floor is heavily loaded. After the lower section of concrete cracks, there is a tendency for the expanded metal to shift in position, and therefore become ineffective. This belief of the writer's arises from observations of heavy beams reinforced with concrete and tested to the breaking point. He does not mean to convey the impression that for light beams, loaded comparatively lightly, expanded metal is not a desirable reinforcing material.

SWITCH CELLS AND WIRING SUPPORTS.—The electrically operated oil-switches, which are usually mounted in a brickwork cell structure, were mounted in a cell structure built up of concrete. A collapsible wooden mold was made, set up in the proper position for the switch, and filled with concrete from the top. This mold was built similar to a hinged flask standing on end, and was made large enough to allow of casting two switches at one setting. The mold was properly lined up, leveled, and braced to prevent moving while tamping the concrete. The bolts for holding the switches in place were set in the concrete of the cell structure by means of a template on top of the mold, just as foundation posts for engines are set. The concrete mixture was one part "Universal" cement, two parts torpedo sand, and three parts screened limestone which would go through a ⅝-in. mesh. After the mold was constructed, the only skilled labor required was that of the carpenter, who lined up the mold each time it was moved into a new position. After the concrete had set for approximately 48 hours the mold was stripped and again set up for the next two switches. After all the switches of a row had been cast, and the molds removed, the cement worker went over them to point up any voids which might have occurred in the corners, and to give the whole structure a finished appearance. The result was a pleasing one. It was decided that the mold—which in this case was built of dressed lumber, in the attempt to give a smooth and finished appearance to the concrete work—might better have been of rough lumber, in which case it could have been built for about $50. In case a large number of switches were to be built, however, the speaker would recommend the construction of a metal mold, which would cost perhaps $100. A mold constructed of metal would be free from liability to warp, which always exists in the case of a wooden mold.

The wires leading from the oil-switches were separated from each other by means of barriers built up of thin slabs of concrete. The method of construction of these barriers was simple and effective. Pipes, or 0.5-in. rods, were set up and tied together with wire in the form of the proposed compartment construction. A light metal lath, such as is used for plaster partitions in building construction, was then wired to this framework. A cement mortar was then applied, in the same way as the plaster. The cement worker became so expert in doing this class of work that he could build these compartments more rapidly than a draftsman could make the drawings for them.

The bus-car structure was built up in the same way as was the cell structure for the oil-switches. Where lines left the building, or where they were run in any horizontal position, barriers were suspended from the ceiling by allowing a piece of metal lath to project down at the time the floors were put in. The barrier was plastered to this piece of lath in the same way as just described. Where conductor wires were taken through the floor, which, of course, was frequently necessary, the insulators were set into the concrete as the floor construction progressed; therefore, when the floor and switch construction was completed the wiremen had the insulators, through which the wires were to be run, properly located.

One great advantage of this form of construction rests in the economy of space which it makes possible. Any brick wall must necessarily be 4 ins. thick, whereas a concrete wall may be put up only 2 ins. thick, provided it is reinforced. In case brick construction is employed, where thin partitions are desired, they must be built of soapstone or marble. The concrete is just as effective in most cases, and is much cheaper.

In constructing the switch-cells and bus-bar structures, an attempt was made to obtain a perfectly smooth finish by dressing the mold smooth and coating it with shellac, as is customary for patterns. This was found to be a mistake, as the bubbles of excess water contained in the wet mixture tended to gather on the smooth surface and make a rough finish to the work. It was found preferable to leave the mold rough and to finish the work with a final float-coat.

The generator leads were brought from the machines in 3-in. bituminized fiber conduits, laid in the cement floor of the basement. Under the generator switches, they were brought from the basement floor to the engine room floor in a solid concrete wall. The lead sheathing was removed from the cables, and additional coating consisting of paper and shellac was provided. After allowing a few days for this to dry, the cables were built into a wall of concrete. Inasmuch as the wall was only a few inches thick, little difficulty would be encountered in cutting the cables out, if necessary; in fact, three cables were cut out, under the mistaken impression that they were improperly connected. Little difficulty and slight expense were involved in the operation; and the cables were found to be in perfect condition. In the basement, no important wire or cable was permitted to be exposed. The result is that if a fire should start in any material which might be stored there it could not affect the connections to the generators or instruments, nor could it cause the collapse of the structure, due to the failure of exposed steel columns.

The instrument leads and the control wires for the switches are buried in cement. It was originally intended

to use for this purpose lead-covered cable run in an iron-armored conduit, the latter being imbedded in the floors. It was decided later, however, to do without the iron-armored conduit, and to lay the cables directly in the cement floor. For this purpose, a top coat of 2.5 ins. of cement on the floor was allowed, in addition to the original cement floor which was designed to support the full loads. Of this top dressing, 2 ins. consisted of a mixture of cement, sand and sawdust, in the proportions of one of cement, one of sand and two of sawdust. The method of installation consisted of laying the conductor cables on the top of the original supporting floor. When all the instrument wiring was completed and tested, the cables were covered and imbedded in this mixture of sawdust-cement, and on top of all was laid a 0.5-in. finishing coat for the floor. The mixture of sawdust-cement is soft enough to permit of chopping a cable out at any time without damage to the cable, or to surrounding cables. The repair of the floor is very simple, and the floor is perfectly solid and to all intents and purposes the same as if constructed wholly of concrete. The necessity for chopping out cables is very remote, because, once properly installed, there is no chance for movement or damaging of the cables. The item of labor saved by making it unnecessary to draw into the conduit the very great number of cables which are required for the installation of electrically-controlled switching apparatus is very considerable.

The 20,000-volt wires which were led from the transformer room on the first floor to the lightning-arresters and building outlets on the top gallery were provided with thorough protection where they passed through the operator's gallery. For each wire a chimney was built of 10-in. bituminized fiber conduit. The three chimneys carrying the three wires of a circuit were placed together and were surrounded with a construction of expanded metal lath, covered with cement plaster. The result was, to outward appearance, a rectangular column. In effect, there was a thoroughly-insulated duct provided for the conveyance of each high-pressure wire, which acted to prevent entirely the possibility of an operator coming into contact with these wires in any way.

After the installation of all apparatus and connections thereto, the cement work was given a final finishing wash of whiting, glue, and a slight amount of dark coloring matter, producing a uniform natural cement color over the whole job. It is impossible to produce this without some such wash, since all cement work will discolor more or less as it dries out.

The final result is most pleasing from both engineering and artistic standpoints. Not much effort was taken at the start to lay out the work with a view to insuring good architectural lines, but even though this was not looked to as it might have been, it was possible, by adding a touch here and there, to get some very satisfactory effects from the standpoint of appearance. Of recent years, most large power-houses are designed with a view to obtaining good architectural lines on the exterior, whereas the interior is generally designed from an engineering standpoint only. The possibilities of cement construction in insuring artistic and decorative interior effects, with very slight increased cost, and without sacrificing engineering requirements, have so far received too little consideration.

FOLDING DOORS FOR FREIGHT HOUSES AND WAREHOUSES.

Doors which fold vertically are being used by a number of railways and industrial establishments for freight houses and piers, stables, warehouses, etc. The accompanying illustrations represent two types of folding doors which are now in service.

THE RITTER DOOR.—The first of these is a new design of folding door which is in use at one of the Cincinnati freight houses of the Cincinnati Southern Ry. The door is made in three horizontal panels, the upper one being smaller than the others, as shown in Fig. 1. The panels are attached to three iron bars on each side, making (with the panels) a sort of lazy-tongs arrangement. The heels of the two lower bars slide on a vertical rail at the side of the opening, while the upper bar revolves on a fixed pivot. The lower corners of the bottom panel have lugs with rollers running on the vertical rails, and to these lugs are attached the operating chains, which pass over grooved sheaves fastened to the wall; a counterweight is suspended from the ends of these chains. The shaft of the grooved sheaves has a spur wheel gearing with a pinion on the shaft of a small sprocket wheel driven by an endless chain, as in an ordinary chain hoist. As the chain is operated, hauling up the door from the bottom, the three panels swing inward and upward, as shown in Fig. 2, and finally fold close together horizontally at the top of the opening, as shown in Fig. 3. The door can be opened a few inches and locked in that position (similar to Fig. 2, but with less opening), so as to allow for ventilation. It can be built of wood or steel, but the doors now in use are of wood. This door is the invention of Mr. Adam Ritter, Assistant Engineer of the Cincinnati Southern Ry. at Cincinnati, and it is being introduced by Mr. Jesse W. Walker, M. Am. Soc. C. E., Bissell Block, Pittsburg, Pa.

THE CROSS DOOR.—Another style of folding door, which is in extensive use for freight stations and piers, warehouses, etc., is the Cross door, shown in Fig. 4. This has two horizontal panels attached to each other by large strap hinges, but the upper one has only a swinging motion, and does not slide. This upper panel extends above the opening and revolves on pivots, while the bottom corners of the lower panel have rollers running against vertical guide rails at the sides of the opening. The operating chains (or cables) are attached to these bottom corners and pass over grooved sheaves in a frame attached to the wall at one side of the top of the openings. Ordinarily the doors are operated by handles on the lower panel, and as this is raised the [illegible] fold together until the lower panel lies in [illegible] zontal position at the top of the openi[illegible] very high or heavy doors, however, a [illegible] gear is used, as in the Ritter door describe[illegible]. The door may be made of wood or steel, a[illegible] wire-glass panels, if desired. In Fig. 4 [illegible] shows part of the interior of one of the [illegible] freight stations, the door at the left and [illegible] the doors at the right are partly open, whil[illegible] between them are entirely open. The [illegible] freight house of the Delaware, Lackaw[illegible] Western Ry. has 82 doors (some of them [illegible] ft.), while the Chicago freight station of th[illegible] Shore & Michigan Southern Ry. has 120 [illegible] (of wood and wire glass), separated only b[illegible] columns. Some warehouses in Chicag[illegible] Cross folding doors 18 and 22 ft. wide.

Vertical sliding doors are sometimes used [illegible] the height of wall above the doorway p[illegible], and the Cross sliding door for such cases has two panels, so that the height occupied by the door when open is only half the height of the doorway. The Cross folding and sliding doors, adapted to numerous purposes, are manufactured by the Variety Manufacturing Co., 77 West Lake St., Chicago.

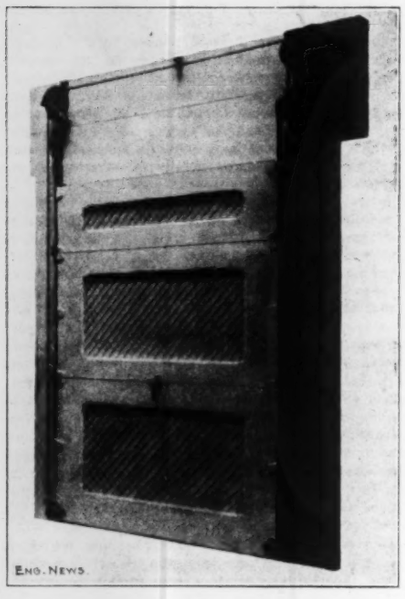


Fig. 1. Door Closed.

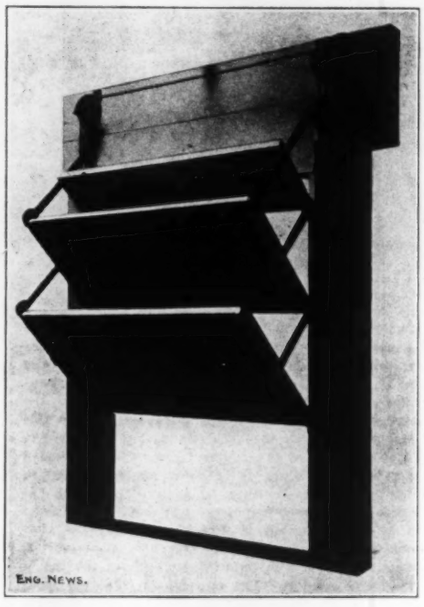


Fig. 2. Door Partly Open.

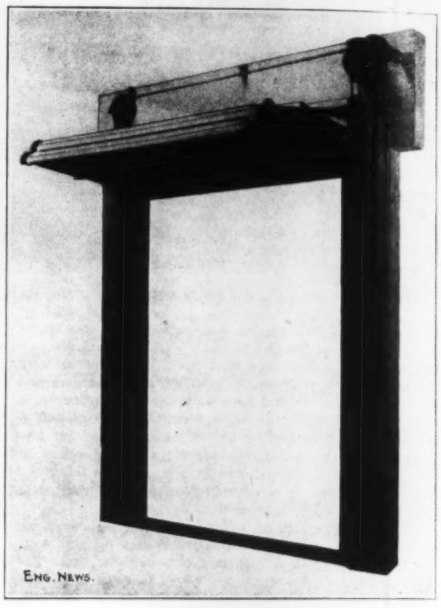


Fig. 3. Door Open.

FOLDING-DOOR FOR FREIGHT HOUSES AND WAREHOUSES.
Adam Ritter, Cincinnati, O.; Inventor.

THE USE OF A NOVEL WATER JET FOR DRIVING PILES FOR THE SANDY HOOK PROVING GROUND RAILROAD TRESTLE.

By Sherman A. Jubb.*

I desire to submit the following facts for the benefit of the many contractors interested in this trestle and in the pile sinking device used in constructing it.

It may be well to say that, in spite of the many predictions of failure, due principally to visionary difficulties and a few real ones, such as storms, wind, sunken wrecks and boulders in the line of the work, the trestle is completed, and in good time, considering the season of the year and the severity of the weather. The contract was completed in 127 working days, the time estimated by the majority of the bidders. The talk in connection with this trestle was so discouraging that many were afraid to bid upon the work; and those who did bid were either very high, or hoped that they were, up to the time the bids were opened.

Bids were opened June 20, 1904, and were as follows:

J. P. Carlin, 26 Court St., Brooklyn, N. Y.....$90,700 00

*Civil Engineer and Supt. of Construction, Quartermaster's Department, U. S. A., Fort Hancock, N. J.

FIG. 4. FREIGHT SHED FITTED WITH CROSS FOLDING DOORS.
Variety Mfg. Co., Chicago; Makers.

New Jersey Foundry & Machine Co., 9-15 Murray St., New York City	89,822.00
William H. Jenks, 130-132 Pearl St., New York City	88,870.00
J. Marvin Briggs, Whitehall Bldg., New York City	83,446.00
James Stewart Co., 135-137 Broadway, New York City	77,400.00
Richard B. Rodermond, 20 Broad St., New York City	74,202.00
A. F. Chapman & Co., 77 White Bldg., Buffalo, N. Y.	60,028.52

The principal items were:

Piles, creosoted yellow pine, 13 ins. at cut-off	38,370 lin. ft.
Yellow pine, long leaf	683,000 ft. B. M.
White oak	26,000 ft. B. M.
Wrought iron (bolts and spikes)	92,000 lbs.
Cast iron (washers and separators)	50,000 lbs.
Steel rails, 70 lbs. per yd	144 tons

In addition to the above there were four frogs, four switches, grading and ballasting the approach—about 800 ft. of single track.

The contract was awarded to A. F. Chapman & Co., the lowest bidders, on July 25, 1904.

The trestle is 4,494 ft. long, 700 ft. of which is double track and extends north, along the beach from near Highland Beach Station, C. R. R. of N. J., which is a place swept by the sea in storms and by the wind from the northwest across the bay, which makes it impossible to maintain a permanent roadway. About 2,000 ft. of this is in the Shrewsbury River in about 9 ft. of water at low tide. The piles all have a penetration of 15 ft. and, where the sand is above mean low water, they are driven to grade—15.

The plant installed consisted of three land and two water drivers, all drop hammers, and for the water jets, two Worthington double acting pumps with 4-in. discharge, which were run under a pressure at the pump of about 130 lbs. per sq. in.

The piles were furnished by the Wyckoff Pipe & Creosoting Company, Portsmouth, Va., and were treated with 15 lbs. of oil per cubic foot.

The pile driving commenced Oct. 5, 1904, and the last pile was driven Jan. 2, 1905. The maximum number of piles driven in a day by one machine was 15, for both land and water drivers. The water for the boilers was obtained from an artesian well which existed at the south end of the site and was said to be 545 ft. in depth. The water gave perfect satisfaction. The borings showed only beach sand and gravel for a depth of 30 ft.

Where the penetration was over 20 ft., one and sometimes two water jets were used; but, for the greater part, where the penetration was less, no difficulty was found in driving the piles without a jet—nor did it make much difference as to the weight of hammer used; in fact, the machine with the lightest hammer averaged the greatest number of piles per day. The weight of hammers used varied from 1,800 lbs. to 3,000 lbs. each, and it was found it took about the same number of blows to drive a pile, and that the penetration per blow was not increased by a greater fall. The average of several hundred piles observed was:

Fall	14 ft.
Number of blows	175
Time	20 mins.
Penetration per blow	1 in.

This was very uniform throughout all the driving, there being only a few instances where there was difficulty in obtaining the required depth. As the weather grew cold and the piles became frozen, care had to be taken to keep them from splitting badly.

The water jet first used was the usual single piece of pipe 2 in. × 18 ft., with a goose-neck on one end and sufficient 2-in. hose to reach the top when fully elevated; the pipe and hose being of such weight as to require a double block at the head of the machine, and two men to raise or lower it by the rope, with one man to keep the hose clear of the work, in addition to the man directing the jet and pile. When the jet pipe reached much below 12 ft. or 15 ft. in depth, it often lost the flow of water to the surface, and it then required four or five men or the engine, to remove it. This required the full attention of the crew on the driver, so that much time was lost between piles—there being no preparation made for the next one. When two jets were used there were, at times, as many as 12 men on one pile. This was, of course, very expensive, and the contractor endeavored to drive without the jet whenever it was at all possible. The writer being much impressed with the inefficiency of this crude apparatus, attempted to improve matters and, as there was good water pressure, this was easier done than was anticipated. He is more surprised that it has not been used before, rather than at the successful working of the jet, which simply uses the water pressure to handle the jet pipe. This can all be done by one man who guides the pipe near the pile. By the turning of a valve he can so control the direction and pressure of the water as to raise or lower the plunger pipe (i. e., the water jet), or hold it in any given place at will. The accompanying photographs, Figs. 1 and 2, show the hydraulically controlled jet, the jet pipe proper acting as a plunger in the larger pipe which is a cylinder into which the water pressure is regulated by a specially constructed valve. The whole apparatus is suspended by a swinging bracket at a fixed height on the sides of the leads of the driver; or, for work where the hammer is not used, swung at the end of a boom to the point of application.

The jet which is patented worked to perfection and immediately reduced the labor to the minimum.

The trestle was built at a cost of about $10.60 per linear foot of track. The average cost of the pile driving was about 15 cts. per linear foot, and the labor on yellow pine lumber about $11.50 per M. ft. B. M.

The work was carried out under the direction of Edwin D. Bricker, Capt. Ord. Dept., U. S. A., Constructing Quartermaster, and J. H. Earl, Supt. for A. F. Chapman & Company.

Fig. 1. A Novel Water Jet Device for Pile Driving.

THE STRENGTH OF MORTAR MADE WITH CAKED cement may be as great as the strength of mortar made with cement in good condition. A table showing the results of tests on Portland cement mortars is given on page 3801, Vol. 8, Part IV. Report of the Chief Engineers, U. S. A., 1904, from which the following has been abstracted:

Character of cement.	Age of mortar when broken.	Tensile strength, lbs. per sq. in.	Number of tests averaged.
Good.	7 days.	176	8
Caked.	7 "	199	2
Good.	28 "	298	8
Caked.	28 "	274	5
Good.	6 mos.	424	8
Caked.	6 "	424	5

The cement that was caked had been exposed to dampness in sacks until caked hard, but not set. It was then pulverized and treated exactly as the good cement was treated, being mixed with 3 parts of standard quartz sand, by weight, to 1 part of cement. See Engineering News, Jan. 5, 1893, for tests showing the effect of retempering mortar.

Fig. 2. Showng the Valve Used in Raising and Lowering the Jet Pipe.

NEW TYPES OF VALVES AND VALVE GEARS FOR LOCOMOTIVES.

The Stephenson valve gear in connection with slide valves of either the flat or piston type is practically a very efficient mechanism for regulating the steam distribution in locomotives, although from a theoretical point of view there are certain objections to be brought against it. Its simplicity, efficiency and low cost of maintenance and repairs have combined to establish its practical value, and although various type of valves and valve gears have been designed and experimented with, the Stephenson gear is still universally used in this country, and in foreign countries it is used more extensively than any other gear. The only rival which has as yet superseded it to any extent is the Walschaert gear, which is largely used in Europe, and seems likely to come into extensive use on large engines in this country, owing to its efficiency combined with a material reduction in weight of parts. This gear was described in our issues of March 31 and Nov. 24, 1904. It may be said, therefore, that the Stephenson and Walschaert valve gears are used almost exclusively in all countries, and that the former is represented by a large majority.

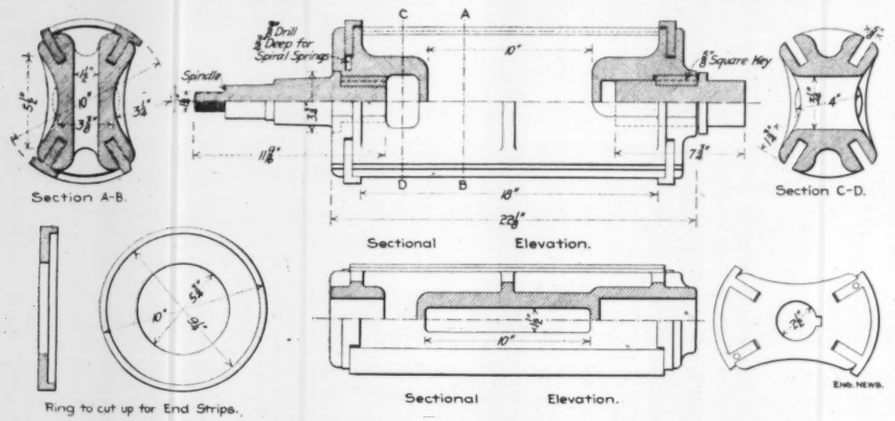


FIG. 1. YOUNG'S CORLISS VALVE FOR LOCOMOTIVES; CHICAGO & NORTHWESTERN RY.

Notwithstanding these conditions, numerous attempts continue to be made to design valves and valve gears which will give a better steam distribution than the Stephenson system. Some of these have been tried experimentally, but few have so far established any practical superiority, the difficulty in most cases being that the economy in steam consumption is more than balanced by higher cost of maintenance and repairs (due to complication or other defects), or by a general unhandiness of the mechanism. In regard to the question of complication, however, it was shown in an editorial on four-cylinder balanced-compound locomotives in our issue of March 31, 1904, that simplicity in design means not simply a minimum number of parts, but also a reliable and durable construction and arrangement, in order to ensure ultimate economy.

Three new types of valves and valve gears designed to improve the steam distribution of locomotives are now in use in this country, and we give herewith some particulars of the mechanism and of the results obtained in each case. In each of these three designs the Stephenson link motion is employed, supplemented by mechanism for improving its efficiency in steam distribution.

THE YOUNG SYSTEM.

This is, in general principles, an application of the Corliss system to locomotive work. It is the invention of Mr. O. W. Young, of the Young, Mann, Averill Co., of Chicago, and has been fitted to two passenger engines of the Chicago & Northwestern Ry., with highly satisfactory results. Each cylinder has a pair of oscillating horizontal valves, mounted in cylindrical chambers above the cylinder, and having their axes at right angles to that of the cylinder. Each valve controls the steam admission and exhaust at one end of the cylinder. One of the valves is shown in Fig. 1. The valve works in a bushing, Fig. 2, and is fitted with four horizontal packing strips, but its weight is carried by end bearings and does not come upon the bushing. The packing strips divide the chamber into steam and exhaust compartments, and four strips at each end isolate the exhaust compartment, live steam being allowed to pass around the ends of the valve.

The steam enters the chamber through 2-in. ports in the side of the bushing, Fig. 2, and passes out through ⅞-in. top and bottom ports, connecting with the cylinder passage. The exhaust returns through the same two openings into the chamber and thence escapes through the valve to the exhaust passage by a 1⅝-in. port near the bottom of the bushing. When the valve has reached the end of its travel, one of the longitudinal strips laps over a groove in the face of the bushing.

The valve gear, Fig. 3, is of the Stephenson type, with eccentrics, link and rocker, but the valve rod A from the rocker arm is attached to a T-shaped wrist plate, B, from which the valves are operated by short connecting links, C, attached to arms D on the valve stems. The lead is normally 1-32-in., but is varied automatically by the operation of the reversing lever. The wrist-plate bearing is carried on the horizontal arm of a bell crank, which has a fixed bearing for its center. The vertical arm is connected by adjustable rods, F, to an indirect rocker, G. On the reversing shaft is an arm, H, carrying a rod, J, which is connected to the rocker above mentioned. Then as the reversing lever is moved to raise or lower the link, the wrist-plate bearing is moved slightly in a vertical arc, thus moving the valves so as to regulate the lead in accordance with the changes in cut-off. With the shorter cut-off the steam lead is slightly increased, and the exhaust lead increased in greater proportion, while the exhaust lap for long cut-off is changed to an exhaust clearance. This gives maximum power in starting, and sufficiently late compression to prevent the terminal pressure from exceeding the initial pressure, even at high speeds.

One of the locomotives equipped with this gear is of the Atlantic type, with cylinders 20 × 26 ins., driving wheels, 6 ft. 9 ins. diameter, and a weight of 158,000 lbs., of which 91,000 lbs. are on the driving wheels. The boiler pressure is 200 lbs., and the cylinder clearance is 6%. The valves have a travel of 3½ ins. on the face, and are set with 1-16-in. negative lead in full gear, and 1-16-in. lead with 6-in. cut-off; they have 1 in. lap. The exhaust ports are set line-and-line in full gear, and have ⅛-in. clearance with 6-in. cut-off. The steam ports give an opening equivalent to ⅞ × 34 ins. The eight-wheel engine first equipped had only 3% clearance, but this was found to be too small. This gear can be used to advantage with very short cut-off. Indicator cards are very favorable, showing a free opening for both admission and exhaust, and an absence of excessive compression even at high speeds.

According to a statement issued by Mr. Robert Quayle, Superintendent of Motive Power and Machinery of the Chicago & Northwestern Ry., the cost of cylinders and valves, and including the necessary changes in the valve motion, should not exceed that for an ordinary engine by more than 30%, or $150 per engine if the design is standard. The first engine was equipped in [illegible], and the second in September, 1903, the [illegible] being used in various kinds of service by various crews. By October, 1904, it had about 90,000 miles, and had demonstrated that the wear and tear on machinery was very much less than on engines with flat or piston valves. The reason for this is that the [illegible] effort at the most effective points is higher and more uniform with the new valve and gear, and this also results in a greater turning effort in starting, thus reducing the slipping of [illegible]. The roundhouse foreman reported that as far as repairs went, five engines of this type would equal seven engines with piston slide valves. The train dispatchers soon found the value of this engine, and did not hesitate to rely on it to make up time or take an unusually heavy train, the consequence being that the improvements shown by the indicator cards are not entirely realized in actual performance. There is one run between Chicago and Clinton, 138 miles, usually with ten heavy cars, on which this was the only engine that could make time. In a series of comparisons made with the use of the indicator, the water rate per I. HP. was reduced from 22.9 lbs. with the ordinary piston-valve engines to 19.3 lbs. with the Young engine. The cards are remarkably full, the expansion lines being clear and distinct at all points of cut-off. Most of the work is done at less than 6 ins. cut-off. While the experiments have so far been made in passenger service, it is considered that in freight service the performance should show even better results in operation and in economy.

In supplementing this statement, Mr. Quayle writes us as follows:

The interesting part to the practical man in the roundhouse is that this engine comes in and out of the roundhouse without the usual repairs needed by the ordinary type of locomotive. I call your attention also to the fact that the tires are giving us just exactly double the service that the same make of tires does on the same type of locomotive without the Young valve. This is, no doubt, due to the better distribution of steam.

From a paper read by Mr. Young at the December meeting of the Western Railway Club we take the following remarks:

The limit of effectiveness at high speeds is fixed by the capacity of an engine to expel steam from its cylinders.

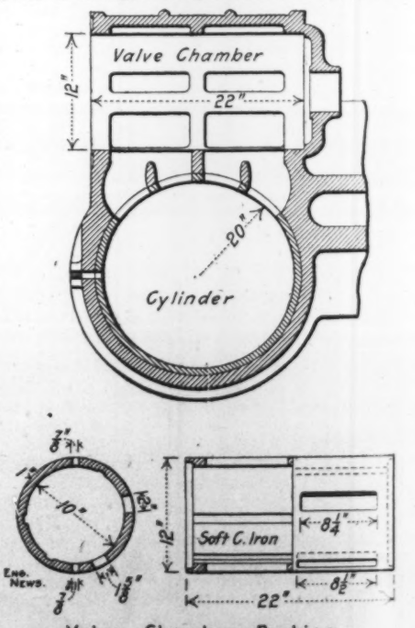


Fig. 2. Cylinder, Valve Chamber and Bushing.

Look at the fastest indicator cards you have been able to obtain and they will show a mean back pressure equal to or exceeding the mean effective pressure, and it is only by reducing this back pressure that the effective work can be economically increased.

One feature of the Stephenson link motion that is sometimes unfavorably criticized, but which, in my opinion,

is one of its most essential elements for producing high speed. In the early release its motion causes for the shorter cut-off. At what period of the stroke during high speed does exhaust occur? Is it not between the point of exhaust opening and the end of the stroke? The indicator very rarely shows a lower back pressure in mid-stroke than at the beginning; on the contrary, it is usually higher, and it is very evident that the advancing piston is obliged to push out whatever pressure of steam remains in the cylinder at the moment of its return stroke, as it is impossible for this steam to escape with greater rapidity than that of the decreasing cylinder volume caused by the moving piston. In order to secure a low back pressure during the entire stroke, a low initial back pressure is very essential, and to secure this an early and free release must be provided.

To improve upon the steam distribution as limited by the Stephenson link motion, a special mechanism must be introduced. This special mechanism must fulfill the following requirements: The motion of the valve while uncovering the port, both for admission and exhaust, should be rapid in order to secure large port openings and decisive events. Release should be slightly earlier and compression later than can be produced by the link motion and this can be done only by increasing the inside clearance of the valve. An excessive inside clearance, such as would be advantageous at high speed and short cut-offs, would be a positive disadvantage when starting and at slow speeds in long cut-offs, therefore, the extent of this clearance should be dependent upon the position of the reverse lever and vary with the different cut-offs. As this is difficult of accomplishment in a single valve, it is better to provide a separate valve for each end of the cylinder; then in order to permit the greatest possible range of variation in exhaust clearance, a separate exhaust passage from each valve to the atmosphere is necessary. The Young valve and gear was designed to meet all these requirements; the results, so far obtained, have justified its application.

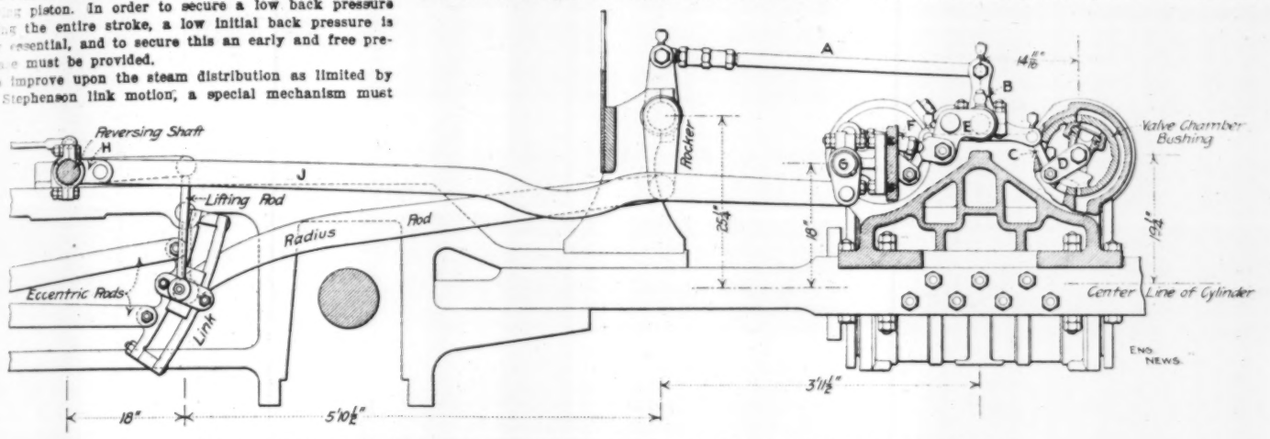


FIG. 3. YOUNG'S VALVE GEAR FOR LOCOMOTIVES; CHICAGO & NORTHWESTERN RY.
Young, Mann & Averill, Chicago, Ill., Makers.

THE ALLFREE-HUBBELL SYSTEM.

In this system the Stephenson link motion is supplemented by a movable connection between the rocker shaft and the valve rod, which varies the relation of the crank to the rocker arm so as to properly fix the valve event. The arrangement is clearly shown in Fig. 4. The rock shaft is driven in the usual way by a rod from the link near the guide yoke is a vertical lever, C, the long lower end of which is connected by a rod, D, to the crosshead, while the upper end is connected by a rod, E, to a segmental rack, F, which is journaled on the rock shaft and gears with the pinion B.

The valve is thus operated from the eccentrics and link in the usual way, and the purpose of the sector and pinion gear is simply to time the events of the valve and then to hold their position while the eccentrics and link move the valve. It accelerates and increases the valve travel at all times of port opening; it also retards and decreases the travel during the period between the cut-off and the exhaust opening, and between the opening and closing of the exhaust ports. As the gear has thus only very light work to perform, its wear is extremely small, while its action in reducing the negative work of compression is said to reduce the wear in all parts of the valve gear.

The engines on this system also have a special form of valve and special cylinder construction. The steam distribution to the cylinder is controlled by a long slide valve, which is partly cylindrical, but with flat faces, and supported by riding shoes, as shown. A special arrangement of cylinder ports is employed, the ports being close to the ends of the cylinder, thus avoiding long passages (as in Corliss engine designs), and the distance from the face of the valve seat to the inside of the cylinder is only about 2 ins. The valve is of the inside admission type, so that the exhaust steam is conducted from the ends of the exhaust chest without coming into contact with the cylinder walls or with the valve chamber which contains the live steam and passes downward behind the cylinder heads to the exhaust nozzle. The live steam also forms a jacket over about one-third of the cylinder walls, between the ports.

This improvement in valve gear is the invention of Mr. J. B. Allfree, and its application to locomotives is largely due to Mr. Ira C. Hubbell. It is owned by the Locomotive Appliance Co., of St. Louis, Mo. A number of locomotives on the Allfree-Hubbell system, of different types and for both freight and passenger traffic, have been in regular service for some months on the Central R. R. of New Jersey, the Pittsburg & Lake Erie Ry., the Wabash Ry., the Chicago, Rock Island & Pacific Ry., the Pere Marquette Ry., and other roads. Engines are also being built or converted for several roads.

The special feature claimed for this gear is that it delays the opening of the exhaust port at all points of cut-off, thus holding the steam in the cylinder for a greater portion of the forward stroke of the piston. This results in increasing the ratio of expansion, decreasing the terminal pressure of exhaust (the terminal pressure of compression remaining the same), and thus securing more work from a given quantity of steam admitted to the cylinder. In the same way the closing of the exhaust port is delayed at all points of cut-off, thus reducing the volume in compression and decreasing the negative work of compression and excessive back pressure. It eliminates premature admission, and at working cut-off it gives a larger port opening and a practically uniform lead. It is claimed that by thus decreasing the volume in compression (about 70% decrease) the cylinder clearance is reduced from about 8% to 2½% or less, which results in a reduced demand on the boiler, securing an economy in water consumption and a consequent reduction in the coal bill. In these locomotives a higher mean effective pressure from a given quantity of steam admitted, with a higher initial pressure and more complete expansion, is said to be obtained than under ordinary conditions.

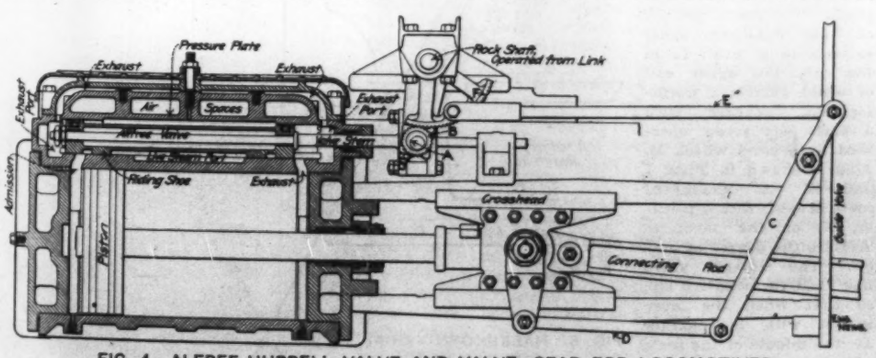


FIG. 4. ALFREE-HUBBELL VALVE AND VALVE GEAR FOR LOCOMOTIVES.
Locomotive Appliance Co., St. Louis, Mo.

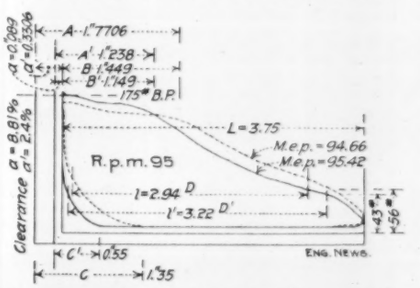


Fig. 5. Comparison of Indicator Diagrams from Locomotives of the Alfree-Hubbell Type and Ordinary Type; Pittsburg & Lake Erie Ry.

	Loco. No.	
Cubic inches of steam admitted to point of cut-off (including clearance),	275	2698.754
	124	3774.498
Cubic inches of steam admitted per pound of M. E. P. (includes clearance),	275	28.283
	124	39.768

Full line shows diagram from engine No. 275, with Allfree-Hubbell system.
Dotted line shows diagram from engine No. 124, with ordinary system.

block. The attachment for the valve rod in the rocker arm instead of being a simple pin, is practically a crank shaft of small throw; the shaft is 1¾ ins. diameter, and the middle portion, A (to which the valve rod is attached), is not concentric with the ends. The ends are carried in the two arms of the rock shaft, and one of them projects far enough to carry a small pinion, B. Pivoted

As an example, mention may be made of two Atlantic engines on the Central R. R. of New Jersey, having cylinders 19 x 26 ins. and driving wheels 7 ft. diameter. One has the ordinary valve gear, and the other is on the Allfree-Hubbell system. When the former cuts off at 7 ins.,

release takes place at 16¾ ins. of the stroke, and compression begins when the piston is 9¼ ins. from the end of its stroke, with 23-64-in. port opening. In the latter engine, when the cut-off is 6½ ins., the release does not take place until 22 ins. of the stroke, and compression does not begin until the piston is within 3 ins. of the end of its stroke, with 28-64-in. port opening. This makes the latter engine more quick and responsive in action, and these qualities (as well as fuel and water economy and increased power) are emphasized by the officers of roads using the Allfree-Hubbell locomotives. On the Pittsburg & Lake Erie Ry. a saving of 15% in water consumption was reported as the result of a 90-day competitive test.

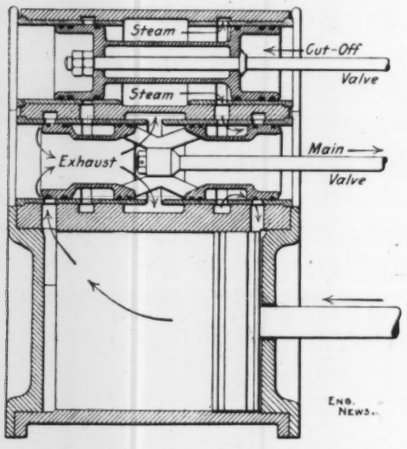


Fig. 6. Plan of Haberkorn Piston Valves for Locomotives.

The following table gives a comparison of two service trips on the Pittsburg & Lake Erie Ry. Both engines were of the consolidation (2-8-0) type, but one had the ordinary balanced slide valve and link motion, while the other had the Allfree-Hubbell valve and port arrangements, and the auxiliary gear supplementing the link motion. Both engines have cylinders 20 × 26 ins., and weigh 140,000 lbs., with 126,000 lbs. on the drivers; heating surface, firebox, 162.5 sq. ft.; total, 2,134 sq. ft.; grate area, 25.6 sq. ft. The driving wheels were 50 ins. diameter on the improved engine, and 49⅞ ins. on the unaltered engine. It is stated that the difference in port volumes in itself accounts for over 8,000 lbs. of the water saved by the improved engine. It is further stated that when the ordinary engine (No. 124) reached the end of this run, it was necessary to uncouple it and run for water, while the other engine (No. 275) had sufficient water in the tank to have hauled the train 11 miles further, or 51 miles with one tank of water. Each tender tank held 8,000 gallons.

	Locomotive No. 124.	Allfree-Hubbell Locomotive No. 275.
Date	5-11-04	5-10-04
Distance run, McKee's Rocks (north yard) to New Castle Junction	40.5 miles	40.5 miles
Tonnage—actual weight	2,500	2,523
Average tons through	2,468.6	2,523
Cars all loads, mixed train	61	62
Cars set out	1	0
Elapsed time	3 hrs. 22 min.	2 hrs. 32 min.
Running time	3 hrs. 1 min.	2 hrs. 32 min.
Average speed (inc. 18.5%)	18.5 mi. hr.	16 mi. hr.
Number of stops	3	0
Slow down	0	1
Water used, actual (dec. 20.82%)	66,050 lbs.	52,300 lbs.
Total ton miles (inc. 2.2%)	99,978	102,181
Water per 100-ton miles (dec. 22.53%)	66.065	51.18 lbs.
Diameter of drivers	49⅞ ins.	50 ins.
Revolution of drivers per mile	404.87	403.36
Area dry pipe, sq. ins.	34.47	34.47
Pounds of water evaporated per hour, per sq. ft. heating surface	10.26 lbs.	9.67 lbs.
Pounds of water evaporated per hour, per sq. ft. grate surface	855.27 lbs.	806.43 lbs.
Size of ports	1¼ x 16	1⅞ x 17
Cylinder clearance in per cent. of vol.	8.8	2.4
Striking distance	1¼ in.	1⅛ in.
Style of valve	Am. Balance	Allfree-Hubbell

Fig. 5 shows a comparison of indicator diagrams from the two engines noted above.

In regard to other roads, we are informed that on the Chicago, Rock Island & Pacific Ry., a ten-wheel (4-6-0) freight locomotive of the Allfree-Hubbell system, with cylinders 20 × 28 ins., hauls trains over heavy grades which have to be "doubled" by similar simple engines with cylinders 21 × 28 ins. or four-cylinder compounds 15½ × 28 ins. and 26 × 28 ins. On the Pere Marquette Ry., mogul (2-6-0) engines of this system with cylinders 20 × 26 ins., 62-in. driving wheels, and 143,000 lbs. on the drivers, haul trains of the same tonnage as ordinary consolidation (2-8-0) engines with 56-in. drivers and 148,000 lbs. on the drivers. On another road, an engine of the Allfree-Hubbell system will handle trains weighing 200 tons more than those handled by ordinary locomotives of the same class, either simple or compound.

A cut-off adjusting gear is used in connection with this valve gear. The main quadrant is carried by the adjusting device, which is attached to the boiler or running board brackets, and is operated by a small latch-handle lever with separate quadrant, the spacing of whose notches is one-fifth that of the main quadrant. After starting the engine with the main lever, this lever may be set in the running position and not again touched until it is necessary to stop the engine. The cut-off is varied as required by the auxiliary lever, which is easily handled, and this relieves the engineman of the muscular strain involved in frequent handling of the main reversing lever. In view of this ease in handling enginemen vary the cut-off more frequently on engines fitted with this device, thus effecting economy in fuel and water. This adjusting gear is the invention of Mr. J. B. Allfree, and is used on many ordinary locomotives as well as those on the Allfree-Hubbell system.

THE HABERKORN SYSTEM.

In this system each cylinder is fitted with two piston slide valves, in separate chambers, Fig. 6, and operated from a double stationary link driven by the usual pair of eccentrics, as shown in Fig. 7. The valve next to the cylinder is the main valve; it is hollow, and each head controls the ports and passages at one end. The outer valve is the cut-off valve, and has solid ends forming a steam space between them. The radius rod, A, of the main valve, extending from the link, B, to the valve stem, is regulated by the reversing lever, C, in the usual way, by means of a reach rod, D, reversing arm, E, and lifting rod, F. The radius rod of the cut-off valve, G, is connected to the second part of the link and operated by a lifting rod, H, on an auxiliary reversing arm, J, whose shaft is bored out to ride on the main reversing shaft. The reach rod, K, of this auxiliary shaft extends to a lever, L, in the cab, the upper end of which carries a worm-segment, gearing with a horizontal screw operated by a hand wheel, M. This is shown in Figs. 7 and 8. A graduated scale is used, with a pointer, N, on the lever to indicate the degree of cut-off. The cut-off valve has 11-16-in. negative lap, so that when the lever is set with the pointer at the middle of the scale (as at starting) the valve is inoperative, as the main valve effects its cut-off before the other valve. The sector of the reversing lever has only four notches, for full stroke, running, central and reversing; for the first two, the cut-off is 90% and 75%, respectively, while for the last it is 80%. The running notch is so placed as to give the engine the proper compression or cushion. With the lever in the running notch, the exhaust closure takes place at 80% of the stroke, and the exhaust at 90%. This is the steam distribution obtained by the main valves, without considering the cut-off valves.

The eccentrics are set in the usual position for valves of the internal admission type, without regard to the cut-off valves. The forward eccentrics give 1-10 in. lead, and the reverse eccentrics 1-5 in lead. The main valve has the usual amount of steam lap, and also exhaust lap to produce sufficient compression to check the reciprocating parts. The cut-off valves with 5 ins travel have 11-16-in. negative lap, as already noted; this, with the 1-in. lead for these valves, gives a distance of 1 11-16 ins. for port closure. They receive their motion from the opposite eccentrics from which the main valves are operated; thus when running forward the reverse eccentrics operate the cut-off valves. To reverse the engine quickly when the main lever is in running position, only the main lever need be used, as the travel and negative lap of the cut-off valve are such that the main valve would control the steam, although both valves would be moving in the same direction. A minimum slow travel of the cut-off valve gives a long cut-off, and maximum fast travel gives a short cut-off. The engine is run with an open throttle and the shortest possible cut-off, this being easily regulated by the worm gear at any speed.

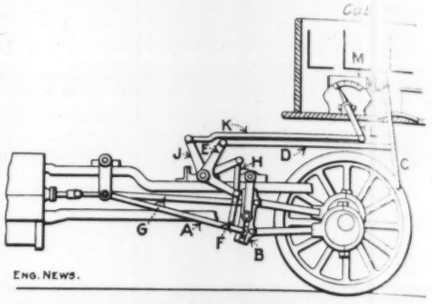


Fig. 7. Haberkorn Valve Gear for Locomotives. Haberkorn Engine Co., Fort Wayne, Ind.: Makers.

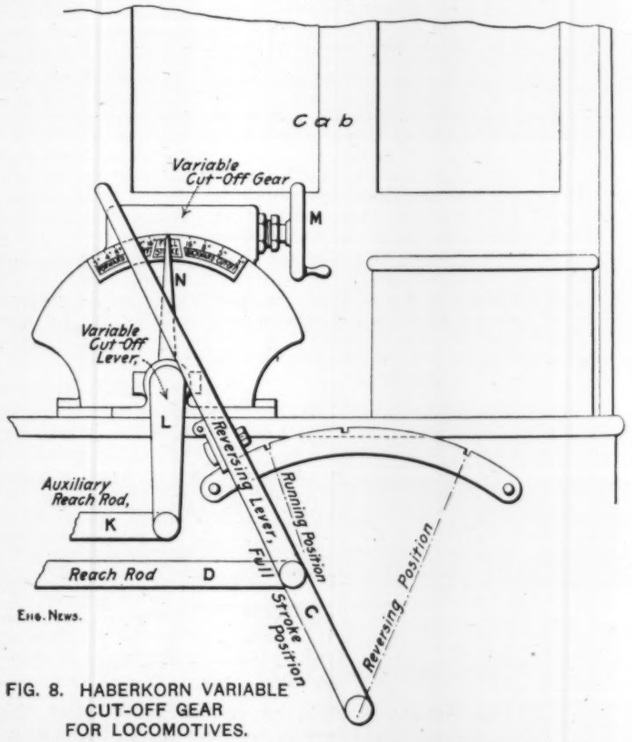


FIG. 8. HABERKORN VARIABLE CUT-OFF GEAR FOR LOCOMOTIVES.

This system of valve gear was designed by the Haberkorn Engine Co., builders of stationary engines, of Fort Wayne, Ind. In 1903 an eight-wheel passenger engine of the Wabash Ry. was equipped with this gear under the direction of Mr. E. F. Needham, Master Mechanic at Fort Wayne, Ind., and after 15 months' service no re-

pairs to the valve gear had been required, although the parts were much lighter than those of the ordinary gear. In January, 1905, the engine was in the shops for general repairs and to have new tubes put in. We are informed that the valves showed very little wear for the amount of service, that the tires were worn evenly (without any flat spots), and that the tubes had lasted three months longer than on similar engines in the same service, but with the ordinary valves and gear. The engine has cylinders 18 x 24 ins., and carried a boiler pressure of 175 lbs. The valves were all 8 ins. diameter with 5-in. travel at full gear; with 25% cut-off this gave 5-32-in. lead and 13-16-in. width of port opening. With such an opening, wire drawing of steam is avoided, even at high speeds. On regular runs of 105 miles in 2 hrs. 13 mins., making five stops and hauling a 360-ton train of six Pullman cars, the engine had an average consumption of 4,400 gallons of water and 8,000 lbs. of coal, as compared with 6,600 gallons and 12,000 lbs. for ordinary engines of the same class in the same service. The cut-off varied from 18 to 25%, the latter being the maximum, except at starting; the ordinary engines, however, required a cut-off of 33%.

The cylinder clearance below the main valve (which space has to be filled during compression)

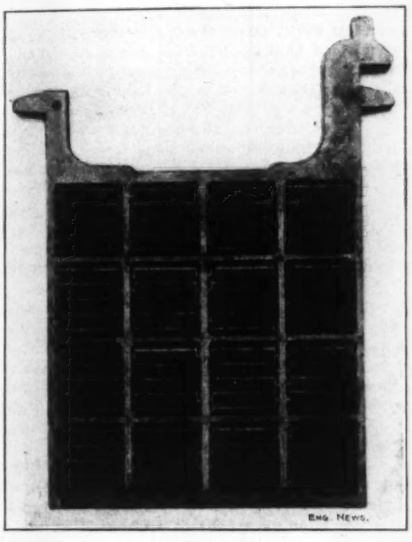


Fig. 1. Unformed Plate, Cell of General Storage Battery Co.

Showing antimonious lead supporting frame, and lead grids welded in place.

is 3½%. Indicator diagrams taken when running with trains show a good steam distribution, with free admission, sharp cut-off, good expansion and late release and compression. The advantages claimed are as follows: (1) Large steam port opening at point of cut-off, assuring high initial pressure up to this point; (2) late exhaust opening, by which greater expansion is obtained; (3) later exhaust closing, which avoids excessive compression or retarding force.

A NEW STORAGE-BATTERY PLATE; THE BIJUR "HIGH-DUTY" STORAGE BATTERY.

The problems of the storage-battery plate are peculiarly puzzling and intricate because of the intermingling which they present of chemical problems but half understood and very severe mechanical and electrical requirements of service. The attention of a great many investigators and inventors has been concentrated on the storage battery for years, and still this important piece of electrical machinery remains delicate, expensive to maintain, and inefficient outside of a closely-limited operating-range. This may be appreciated readily if the nature of the storage-battery plate (referring to the lead—lead peroxide cell, which is practically the only storage cell in use) be considered. The plate is a metallic conducting support on which is held the active material spread in a very thin layer offering a large surface to the electrolyte; the active material at no stage of the action has much mechanical strength, and in addition it is during charge and discharge constantly undergoing chemical transformation and, correspondingly, great change in volume. The change in volume tends in part to break the bond between active material and plate, and in part to actually distort the plate itself. Both actions seriously affect the operation and the life of the cell, and they may in a sense be called the principal problems of the lead storage battery. Most of the great number of storage batteries which are, or at some time were, manufactured, represent attempts to solve these problems.

A new and promising solution is offered by a method of making storage-battery plates which has been perfected by Mr. Joseph Bijur, of New York City, and is used commercially by the General Storage Battery Co. of 42 Broadway, New York. The solution is wholly mechanical, just as the problem of permanently supporting the active sheet on the conducting grid is a mechanical problem. The active material in this plate exists in the form of relatively small net-like structures or "grills," set in a rigid supporting frame in such a way that each grill can expand and contract internally without stressing itself or the supporting frame; the individual grills have a large exposed surface, on which surface the active material is held, and in spite of their freedom to expand and contract they have ample strength, resisting even sharp blows to a surprising degree. Specimens of plates were shown to a representative of this journal recently, and the strength of the structure was demonstrated in actual destruction of a plate by hammer blows.

The features of the plate lie partly in its design and partly in the processes used in manufacturing it. The design will be clear from an inspection of Fig. 1 herewith, which shows a view of an "unformed" plate. The supporting structure is a rectangular frame, about ⅜-in. thick, with several cross-bars in both directions forming smaller panels; this frame is made of a lead-antimony alloy not acted on during the charge and discharge of the cell. The grills of active surface are small squares of pure lead set in the frame panels, about 3 x 3 ins. in size, with rectangular perforations clear through them. The perforations are arranged in horizontal rows, leaving continuous bars across the width of the grill. It will be noted from Fig. 1 that these bars end a short space from the extreme edge of the grill, and come opposite the middle points of the perforations forming the border row. This is an essential element in the design. The grill is attached to the frame, welded to it in fact, along the vertical edges, while at top and bottom the edges of the grill are free. Thus, while the grill is firmly held, it can expand vertically without hindrance; laterally, any expansion of the grill shows by an expansion of its cross-bars, which is then taken up by a slight bending of the strip along the edge of the outer row of perforations, since the cross-bar meets this strip halfway between consecutive supporting bridges.

The expansion and contraction of each grill as a whole is thus taken care of in the design of the grill network. It is obvious, however, that each portion of the grill surface expands individually. The process of charge produces an active layer on the grill surface and on the inner walls of its perforations. These latter are made so wide that the active layer formed from the lead of the grill can never fill the entire width of the perforation, but will always leave room for passage of the electrolyte liquid. The little ring of active material formed in each perforation tends, during its expansion, to lock itself into place, rather than to crack loose or bulge.

The grills are produced by the method of squirting through dies. A standard size is used in various combinations for all sizes of plate.

The absolute junction of the grills with the frame along the edges of the former, by welding, is essential to the construction of this plate. It was not commercially feasible at the beginning of the work of developing the design. By no method of metal working then existing was it possible to commercially weld together two elements, of which one was of heavy solid form and the other of very fine thin parts. It was, therefore, necessary to devise a new method of metal welding which, after many and great difficulties, was successfully accomplished. The method comprises casting the longitudinal frame bars against the surfaces of the grills while the latter are brought to a temperature only just below their fusion. The new metal sets in place without chilling along the contact surface, but rather bringing the contact surface to fusion and thus forming a complete junction. The success of the procedure was shown by many repeated attempts to produce fracture at the junction: the metal always parted at other points. For carrying out this process of welding on a commercial scale, an entire line of special machinery was designed and constructed by the company.

The active material on these plates is formed by an accelerated Planté process, that is, the lead peroxide on the surface is produced by actual charging, in a number of cycles of charge and discharge. The negative plates are similarly formed, and converted to spongy lead by reversal. The peroxide coating exhibited on the specimens shown our representative was exceedingly adherent, so that it could not be cracked or scaled off by bending the metal. This is claimed to result from the process of acceleration employed, the details of which are secret.

The makers claim for the new plate the following, besides practically perfect absence of the possibility of buckling:

In a plate of given dimensions, 20% greater capacity can be obtained with about 10% more reserve lead, than in

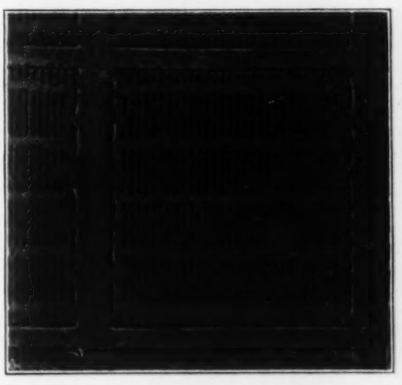


Fig. 2. Section of Plate of Storage Battery After Formation of Oxide.

any form of plate hitherto constructed. The fine subdivision of the oxide into small masses, combined with the fact that the surfaces of the plates are composed of ribbons on edge, precludes the possibility of blistering or shrinkage that is liable to occur when plates contain oxides in large masses. Owing to the rapid acid diffusion full charge may be given the batteries at a voltage of 2.4 to 2.5 volts instead of 2.7 volts per cell as is usually required. This low charging voltage results in increase of efficiency, and reduces the size of boosters required to charge. The structure of the plate forms a conducting net work to all parts, insuring equality of action all over its surface; this, together with the facility for escape of gas without dislodging actual material, favors the ability to stand very high rates of charge and overcharge without marked deterioration.

The weight per unit capacity is practically the same as for lead cells of other type.

Batteries fitted with this plate are being manufactured by the General Storage Battery Co. at Boonton, N. J., under the name of the Bijur High-Duty battery. Cells of all capacities from 3 to 6,000 ampere-hours are being made.

AN ELECTRIC LOCOMOTIVE WITH COUPLING-ROD DRIVE.

A striking departure in the mechanical construction of electric locomotives appears in a group of new locomotives recently built by Ganz & Co., of Budapest, Austria, for the Valtellina line of the Italian Rete Adriatica. The earlier electric locomotives built by the same firm for this railway had the motors (alternating-current induction motors, three-phase, at 3,000 volts) mounted on the locomotive axles, a flexible support for the motors being obtained by mounting them on quills coupled to the axle by elastic couplings. In the new group of locomotives the motors are mounted on independent shafts carrying a crank at each end, and actuate the driving wheels by means of coupling rods. It is suggested that a principal

reason for the change lies in the mechanical difficulties of design and other complications involved in quill mounting.

Fig. 1, herewith, reproduced from the "Zeitschrift des Vereines Deutscher Ingenieure" of March 4, 1905, where Mr. E. Cserhati describes the new locomotives in considerable detail, shows in diagram form the principle of arrangement. Three coupled driving axles are preceded and followed by a truck axle. Each of the two outer driving axles is combined with the adjoining truck axle in a single truck frame connected by center pin with the main locomotive frame. The center driving axle is journaled directly in the main frame. Of the two end trucks, one turns on a fixed center pin, while the other has a yielding socket for its center pin, so that the truck can shift ¾-in. to either side of the middle position. The truck without side-play, in conjunction with the central driving axle, constitutes the "fixed wheelbase" of the locomotive, although even within this base a certain angular adjustment to curves or irregularities is possible.

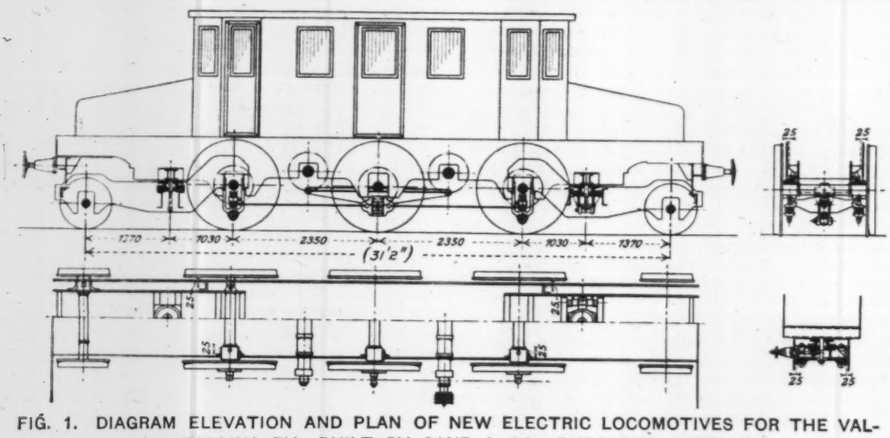


FIG. 1. DIAGRAM ELEVATION AND PLAN OF NEW ELECTRIC LOCOMOTIVES FOR THE VALTELLINA RY., BUILT BY GANZ & CO., BUDAPEST, AUSTRIA.

The two driving motors are mounted on shafts which lie in the spaces between driving axles. These shafts are journaled in the main frame of the locomotive, and also in the shell of the motor; the latter is suspended from the main frame by suspension springs. As the weight of the rotor is carried by the bearings in the main frame, no permanent load comes on the bearings in the motor shell. This arrangement minimizes the usual cause of unequal air gap—the wear of the rotor-shaft bearings in the shell—and therefore reduces the prospective maintenance cost.

The ends of the motor shafts projecting outside the main frame are formed into cranks, whose throw equals the radial distance of the driving-wheel crank pins. On either side of the locomotive a heavy coupling rod connects the crank pins of the two m tor shafts, and in the middle of this rod is provided a vertical slot holding the crank-pin block of the central driving-wheel. The slot and block arrangement is used in place of a bearing fixed in the rod, because the motor shafts, being journaled in the locomotive frame, have an up and down play with respect to the driving wheels.

Fig. 2 presents a view of the complete locomotive attached to a passenger train. In Fig. 3 is given a detai' view of the driving gear, showing the crank on the end of one motor shaft and part of the coupling rod attached to this crank. It will be observed from this view as well as from Fig. 1 that the motor shafts lie above the level of the axles, the distance being made equal to the throw of the cranks. Correspondingly, the slot for the driving-wheel crank pin lies in the lower part of the coupling rod. The jaws of this slot are fitted with pins to which are attached the side rods driving the two outer driving axles.

All the crank pins of side rods, as well as main coupling rod, have spherical bearing in the rod ends, to allow for the pivoting and shifting movements of the several axles. The form of the crank pin may be seen in Fig. 4, a section through one of the motors.

The motors themselves are a radical departure from previous practice in that two motors are combined in a single frame, in such relation that they may be operated in cascade or singly, to give two speeds at full efficiency. Some additional complication in the control mechanism is, of course, involved by this arrangement. The section through a motor, Fig. 4, shows how the two stators and two rotors are structurally combined.

A further novelty in the mechanical construction of the motors is the location of the collector rings outside the motor case, and, indeed, outside the locomotive frame, at the ends of return cranks fitted to the crank pin. This also is shown by Fig. 4. The cables from collector rings to rotor windings pass through holes drilled in the cranks, crank pin and rotor shaft. The principal effect of this arrangement is to give a greater available width for the motors, thereby enabling larger motors to be placed within the limits set by width of locomotive frame. Another effect is to put the collector rings and brushes in a location favorable to easy inspection and repair. A two-part hinged casing surrounds the collector rings, which may be thrown back to expose the brushes and rings. In Fig. 3 this casing is shown open.

In its control and auxiliary mechanism the new type of locomotive follows the older ones. Compressed air is used to actuate the switches and rheostats, with auxiliary electric devices to limit the rate of acceleration. The main resistance, in some of the new locomotives, are water resistances, which form was used also in the earlier locomotives. In these, compressed air forces water in or out of a chamber containing two extended metallic terminals, and the greater or less amount of water between the terminals of smaller or greater resistance to the passage current. One of the new locomotives is f with metallic grid resistances of ordinary c struction, in order to give opportunity for c paring the two forms.

The trolley collector, a roller bow with two i sulated ball-bearing rollers to correspond t two trolley wires, is of the inclined frame t identical in principle with the ordinary tr pole. The frame is raised and lowered by pressure, acting on tension springs. Two pressures are used to give two degrees of pres of trolley against wire, for low and high sp respectively. Separate trolleys are used for ward and backward running, operated by a sin control valve.

The new locomotives were specified to hav wheel loads not exceeding 15,000 lbs. per driver and 11,000 lbs. per truck wheel. The total weight as built is 136,000 lbs., of which about two-thirds, 92,000 lbs., is on drivers. A tractive effort of 13,200 lbs. at a speed of 19 to 22 mi. per hr., and 7,700 lbs. at 38 to 43 mi. per hr., was demanded. This calls for a maximum output of about 900 HP. The specifications required that the locomotive should be capable of an output of twice the above, continued for 200 seconds, and of an output 50% greater than normal continued during one hour, without damage to any part and without heating more than 40° C. above the temperature of the air. Normal load continued for ten hours, at either of the two normal speeds, was to produce a heating not greater than 60° C. in any part of the motors. An insulation test of 15,000 volts on the motors, or 10,000 volts after the 10-hour full-load test, was specified. The locomotives being intended mainly for passenger service, the specifications also covered the item of acceleration. It was required that a train of 440 tons gross weight, on a grade of 0.1%, should be brought to a speed of 19 miles per hour in 55 seconds; a train of 275 tons gross weight on the same grade to a speed of 37 miles per hour in 110 seconds. The locomotive was to be capable of starting a train of 275 tons on a grade of 2.0%, and accelerating it to a speed of 19 miles per hour. These requirements as to acceleration were to be met even with line pressure reduced to 2,700 volts. The trials were completely satisfactory, all rquirements being fully met. On a complete trip from Colico to Londrio and thence back to Lecco an average energy consumption of 44 watt-hours per ton-mile was measured, with a train of 315 tons gross weight. On a heavy-grade portion of the run, the train ran at a speed of 37 miles per hour up grades of 1.2% to 1.7%, giving an output of about 1,500 HP. On an acceleration test with a train of 280 tons weight, drawbar pulls were measured amounting to 19 and in one case even 27.8% of the weight on drivers.

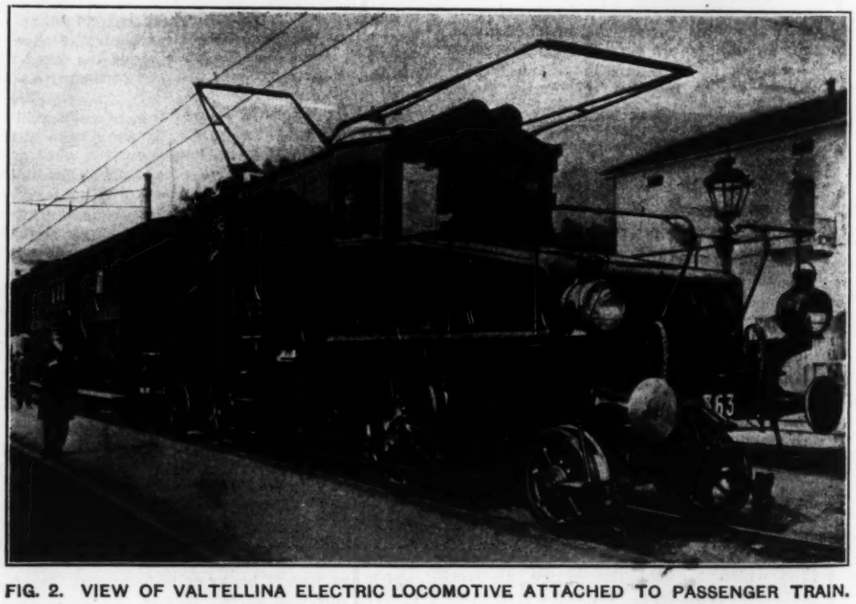


FIG. 2. VIEW OF VALTELLINA ELECTRIC LOCOMOTIVE ATTACHED TO PASSENGER TRAIN.

STEAM RAILWAY MOTOR CARS WITH DETACHABLE ENGINES.

The steam motor car for local service on railway main lines and branches is having a remarkable development in England, where nearly a dozen railways have introduced this class of equipment. Several motor cars with steam and oil engines were described and illustrated in our issue of July 28, 1904, but in all the steam cars then described the engine was an integral part of the car. Three English railways, however, have now introduced cars in which the front end is carried by a small four-wheel locomotive, which forms practically a steam truck and can be readily detached. In each of these cases the machines were built to the designs of the superintendents of motive power of the respective railways.

GLASGOW & SOUTHWESTERN RY.—This machine has a car body 41 ft. long, and the total length including the engine is 60 ft. 8 ins. The engine is an ordinary locomotive with four wheels, and cylinders at the front end; the connecting rods drive the rear axle and the wheels are connected by coupling rods. The boiler is of the ordinary locomotive type, with 138 tubes, 1⅝ ins. diameter, and water is carried in tanks on each side of the boiler. The car has seating accommodations for 50 passengers. The machine was built at the railway company's shops to the design of Mr. James Manson, Locomotive Superintendent.

SOUTHEASTERN & CHATHAM RY.—This machine is in general similar to the one above described, and is 65 ft. long. The engine arrangement is the same, but the Walschaert valve gear is used. Water is carried in tanks on each side of the boiler and in cylindrical tanks under the car body. The car has passenger, smoking and baggage compartments, and seats 56 passengers. It is 48 ft. 4 ins. long, and the total length of the machine is 65 ft. The boiler has 381 sq. ft. of heating surface (337 sq. ft. in the tubes), and 8.8 sq. ft. of grate area. The machine can haul a 16-ton trail car at a speed of 35 miles an hour on the level. It was built by Kitson & Co. to the designs of Mr. H. S. Wainwright, Chief Mechanical Engineer of the railway.

NORTH STAFFORDSHIRE RY.—This is a comparatively small line, but has introduced two steam cars for local service in the main line, stopping at road crossings, etc. The car seats 40 passengers and has side entrances at the rear, with a baggage compartment at the front end. Under the rear of the car is a four-wheel truck (as in the other cars mentioned). At the front end, the steel side sills are extended forward and attached to the plate frames of a four-wheel locomotive, and there is a flexible coupling between the engine and the car underframe, so that the engine has a swiveling or radial motion. The engine is of peculiar design: the cylinders are outside, just forward of the rear wheels, and are connected to the front wheels, but no coupling rods are used. A steel cab extends from the car body to the smokebox. The two cars were built by Beyer, Peacock & Co., to the designs of Mr. John H. Adams, Locomotive Superintendent.

The leading dimensions, etc., of these three styles of steam cars are given below in tabular form:

	Glasgow & S. W. Ry.	Southeast & Chatham Ry.	No. Staffordshire Ry.
Engine wheels	42 ins.	43 ins.	44 ins.
Rear truck wheels	42 "	42 "	42 "
Wheelbase, engine	.....	8 ft.	9 ft. 6 ins.
Wheelbase, rear truck	.....	8 ft.	8 " 0 "
Wheelbase, total	.....	.....	38 " 11 "
Distance from engine pin to truck pin	39 ft. 0 ins.	42 ft. 0 ins.	30 " 2 "
Length of car body	41 " 0 "	48 " 4 "	.....
Length over all	60 " 8 "	65 " 0 "	50 ft. 2 ins.
Weight on driving wheels	.....	54,880 lbs.	21,840 lbs.
Weight on all engine wheels	.....	54,880 "	40,320 "
Weight on rear truck	.....	30,240 "	32,480 "
Weight, total	.....	85,120 "	72,800 "
Cylinders	9x15 ins.	10 x 15 ins.	8½x14 ins.
Heating surface, tubes	400 sq. ft.	337 sq. ft.	.....
Heating surface, total	440 sq. ft.	381 sq. ft.	.....
Grate area	8 sq. ft.	9 sq. ft.	.....
Water capacity (U. S. galls.)	600 galls.	480 galls.	540 galls.
Coal capacity	1,680 lbs.	1,680 lbs.	1,680 lbs.
No. of passengers	50	56	40

RAILWAY DEVELOPMENT IN PERU.

By C. Reginald Enock, C. E.*

Peru is one of those South American Republics which may be expected shortly to come to the front as a progressive nation, and along somewhat similar lines to those which have been followed by Mexico, and which have brought that country to so marked and prosperous a condition. Governed now by an honorable and wise administration, whose efforts are towards peace with its neighbors, and progress within its frontiers, Peru appears to be upon the eve of a real-era of development.

The first step in this development is that of extending its railway system, following upon the recent movement among capitalists, British and American, towards the opening up of the country's great mining resources.

The present railway system consists of lines which run from coast ports towards the interior; there are none, so far, running longitudinally either upon the coast or the uplands. Peru, it will be recollected, consists topographically of (1) the coast lands, (2) the slopes and tablelands of the cordillera of the Andes, and (3) the vast "Montana" or plains of the western portion of the Amazonian basin. Of the various railways which exist, and which run always towards the cordillera, two cross the Andes, viz., the famous Oroya Railway or Central Railway, and the Southern Railway, via Arequipa. The first reaches a height of 15,642 ft. (the highest in the world), and the second of 14,666 ft., upon the points where they pass the respective summits. The other railways run but short distances inland; the total length of all these systems being about 1,000 miles. Of this sum the Oroya takes 138 miles, but is now in operation to Cerro de Pasco by an American company some 60 miles beyond, whilst the Arequipa line is 419 miles in length to its present terminus. This mileage, for a country 1,700 miles long and with an area of nearly three-quarters of a million square miles, is small, but several extensions are about to be actually carried out, which will somewhat increase it.

These extensions may at present be divided into two classes, viz., those lines upon which construction is actually about to begin, and those which are only projected, but which, nevertheless, have been surveyed by the government engineers, and which form part of a definite plan.

In the first category are the following: (1) Sicuani to Cuzco. Sicuani is the present terminus of the Arequipa, or Central Railway, which begins at the port of Mollendo. Cuzco is the old Inca capital and the center of an important agricultural district. The extension will be about 75 miles long. (2) Lima to Pisco and Ica. This line will follow the coast, leaving the capital—Lima—and arriving at the port of Pisco, from whence a line is already in operation to Ica, the center of a large vine and cotton-growing region. The line will be about 150 miles long. (3) Oroya to Huancayo. Oroya is upon the Central Ry., and Huancayo is an important city in the center of an agricultural and mining district; distance about 50 miles. This line will form part of a proposed longitudinal system to unite with the Southern Ry. (4) Chimbote to Recuay. Chimbote is a coast port, one of the finest harbors on the whole coast line of the continent, and Recuay is a mining center. This line will pass through the long and fertile valley of Huaylas, passing the city of Huaraz, giving outlet to its produce, and stimulating the working of the coal, silver and gold mines which abound in the region. The part remaining to be completed of this line will have a length of 138 miles. These lines are to be built principally by the Peruvian Corporation of London, who control and work the country's railways generally, although other interests are principally responsible for the two latter constructions.

Although, judging by the railway system of North America, these of Peru are small, nevertheless they will be of very great advantage to the country, putting into touch with the coast various capitals of the interior States, and giving access and outlet to rich mining centers.

Of railways in the second category or only at present surveyed and projected, are (1) a line which will leave the Chimbote Railway near its present terminus—Suchiman—and arrive at a point upon the Maranon River where navigation to the vast Amazon fluvial system begins. (2) A line which will run from near Sicuani, on the Southern Ry., and which will also be directed to the navigable affluents of this river system, but greatly to the south. (3) A continuation of the Oroya Ry. towards the fluvial system also, via the city of Huanuco, and to Port Victoria, or some other port on the Pichis or Pachitea rivers, where navigation begins.

It is seen, therefore, that the main objects of

*Civil and Mining Engineer, Portal; Apartado 935, Lima, Peru.

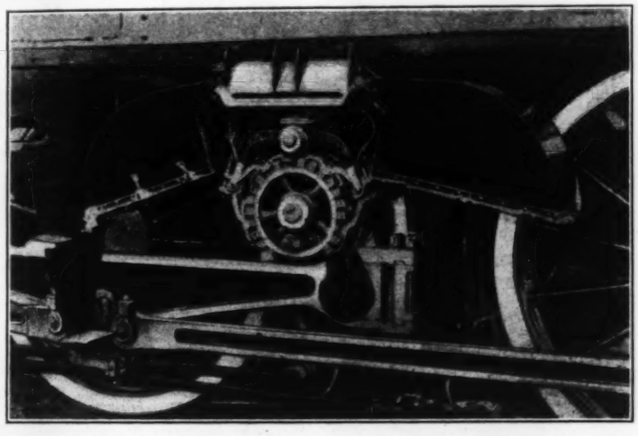


FIG. 3. DETAIL VIEW OF MAIN COUPLING ROD; COLLECTOR RINGS, ETC.

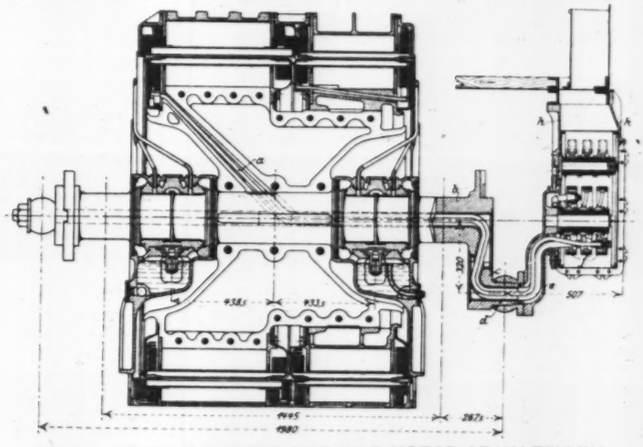


FIG. 4. SECTION THROUGH DOUBLE MOTOR OF VALTELLINA LOCOMOTIVE.

these latter projects is to obtain through communication from the Pacific Coast, via the Andes, to the navigable waters of the Amazonian system, and so to the Atlantic Ocean. This is an exceedingly important matter for Peru, both from a commerical and a strategic point of view, and funds have been set aside to pay the interest on foreign capital which should embark in the enterprise, an enterprise which is not without many points of allurement for capitalists, considering the vast wealth of the virgin zone which such a line would traverse.

The Pan-American Ry., the Peruvian part of which would traverse longitudinally some of the high tablelands of the Andes, with its mineral resources, still remain apparently a dream for future accomplishment, for some new Rhodes of American Cape-to-Cairo ideals!

The writer, after two years of constant travel in these regions, is much impressed with the scope which exists for mining, and other enterprises, such as those which have been described.

THE CERRO DE PASCO RAILWAY.

As noted in the preceding article, an American company, headed by Mr. J. B. Haggin, last year completed a line of railway from the terminus of the famous Oroya Ry. to the historic silver mining district of Cerro de Pasco. The engineers in charge of the work were Messrs. F. W. Blackford, M. Am. Soc. C. E., as Chief Engineer, and Messrs. W. H. Harrison and A. Bentzon, Assoc. M. Am. Soc. C. E., as Division Engineers. We were favored by Mr. Blackford, some time ago, with information regarding this road, which we present as follows:

Surveys for the line were begun in May, 1902, construction began in October and the road was completed to Cerro de Pasco on July 7, 1904.

The road is 82 miles in length. It starts from Oroya, the terminus of the well-known Oroya Ry., at an altitude of 12,250 ft., climbs to the Junin Plateau with a maximum grade of 2¼%, and runs thence to Cerro de Pasco, which is at an altitude of 14,200 ft.; using a maximum grade of 1.5%. The maximum curve is 16°. Throughout its length the road is one of the highest in the world. Some parts of the work were reasonably heavy, but no especial engineering difficulties were encountered. The road is laid with 70-lb. steel rails made in England; other supplies and all of the equipment is American. All bridges and culverts are of substantial masonry or concrete and the iron work is of American manufacture.

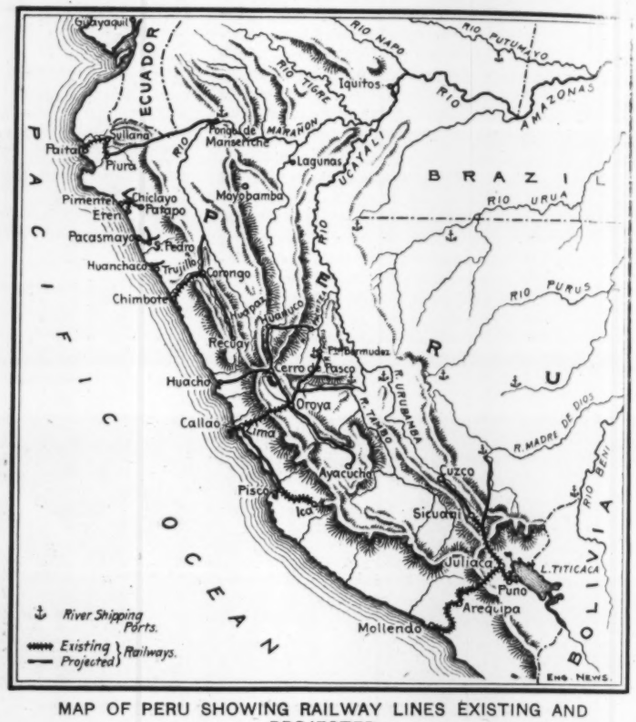
On July 28 the formal opening of the railway was celebrated with appropriate ceremonies by the citizens of Cerro de Pasco, and the American engineers were presented with gold medals struck in celebration of the event.

The accompanying photograph was taken during the ceremonies held in celebration of the completion of the railway.

REPORT OF THE NEW YORK BAY POLLUTION COMMISSION.

The Passaic Valley trunk sewer scheme has received another blow, this time in the shape of an unqualified disapproval by the New York Bay Pollution Commission,* appointed in 1903 to investigate the "threatened pollution of the waters of New York Bay." As the highest court in New Jersey has recently declared unconstitutional the act authorizing the construction of the sewer, the condemnation of the scheme by a New York commission will have little present effect. It will, however, strengthen the opposition to the trunk sewer in both New Jersey and New York, and in itself or in action to which it gives rise it may be a factor in the long-deferred solution of the Passaic valley sewage disposal problem.

Ten years ago this coming summer unusually low water in the Passaic River combined with the increasing sewage pollution of that stream gave rise to such offensive sights and smells that mass meetings were called to protest against the nuisance and a committee was appointed to secure legislation designed to abate it. In the next few years three or four commissions were created by the legislature to study the problem of abating the nuisance. The first commission, acting u the advice of the late Alphonse Fteley, re mended a trunk sewer from Paterson to Ne Bay, to intercept the sewage of the two named and other municipalities on the ea slope of the first range of the Orange Mts. posal was to be by dilution in Newark Bay. outlet sewer was to discharge opposite Bayo and some of the citizens and officers of that made vigorous protests against such a plan.



MAP OF PERU SHOWING RAILWAY LINES EXISTING AND PROJECTED.

*The Commission was authorized by Chapter 539 of the New York Laws, approved May 11, 1903; was named on June 2, and held its first meeting on June 30 of that year. The committee was appointed by ex-Governor Odell, as follows: Dr. Daniel Lewis, Health Commissioner of the State of New York; Prof. Olin H. Landreth, Consulting Engineer of the State Department of Health; Dr. George A. Soper, Sanitary Expert; Prof. Myron S. Falk, Department of Engineering, Columbia University, and Louis L. Tribus, Consulting Civil and Hydraulic Engineer and Commissioner of Public Works, Borough of Richmond, City of New York; Dr. Lewis was elected chairman and Mr. Tribus was made secretary of the Commission.

subsequent commission, with Hering & Fuller as consulting engineers, caused more extended studies to be made and reported, in concurrence with Hering & Fuller, in favor of extending the trunk sewer across Newark Bay, across Bayonne, and into New York Bay at Robbins' Reef, ending in 40 ft. of water. In 1903 this same commission was authorized to execute the plan outlined and to issue bonds for the same, provided it should find on further investigation that the proposed discharge of sewage into New York Bay would not be a nuisance, said finding to satisfy the Attorney General of New Jersey that the sewage discharge would not create grounds for a suit for damages or injunction on behalf of New York State. A special commission of engineers was appointed by the district sewerage commission, and after an investigation it also reported in favor of the Robbins' Reef outlet. Accordingly the district commission was authorized by the Attorney General and Governor to issue bonds for the work, but before it could do so the city of Paterson secured a temporary restraining injunction. The Supreme Court of New Jersey declared the district sewerage act constitutional, but on March 6, 1905, the Court of Errors and Appeals, with only one Judge to the contrary, declared that the sewerage district and the taxes sought to be imposed by it to meet the cost of the trunk sewer were unconstitutional. Following close upon this decision is the report of the New York Commission, already mentioned.

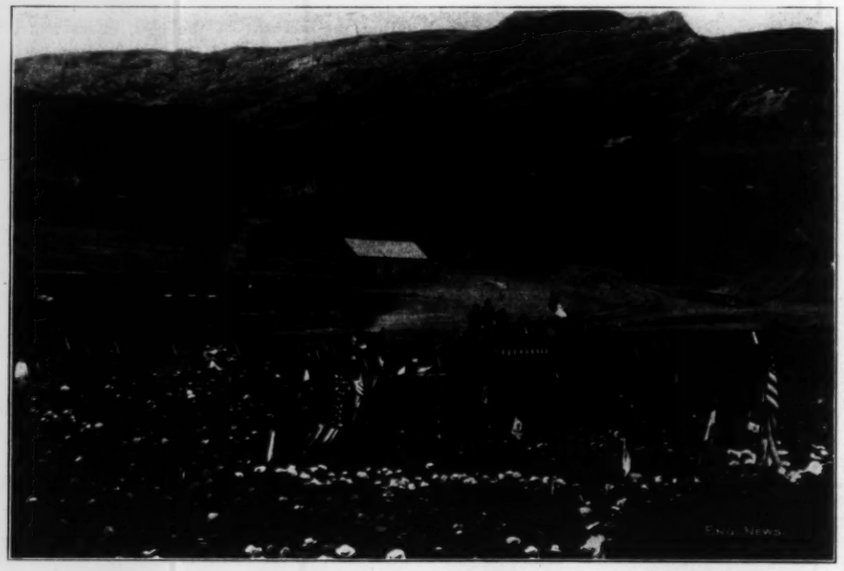
The New York Commission divided its work among its members, each of whom made studies and reports as follows:

Tidal action and river flow in Harbor of New York, by Myron S. Falk.

Present sources and estimated quantities of sewage coming from different communities in and about New York Harbor, by Louis L. Tribus.

Sanitary and bacteriological analyses of New York Harbor waters and fisheries and industries affected by pollution, by George A. Soper.

(A) The history, laws, reports and plans of the New Jersey project, and (B) Ocean disposal as a possible solution for all the metropolitan sewage, by Olin H. Landreth.



THE BUILDING OF AN AMERICAN RAILWAY LINE TO CERRO DE PASCO, PERU.
CEREMONIES AT THE FORMAL OPENING OF THE LINE FOR TRAFFIC.

Needs of the Metropolitan District as a whole and desirability of joint state action, by Daniel Lewis.

On the first three of the foregoing topics we quote the report proper (not the appendixes) in full as follows:

TIDAL CONDITIONS, NEW YORK HARBOR.

Assuming that the Passaic Valley trunk sewer has been constructed with one, two or three outlets north of Robbins' Reef light, the action of the tidal currents would very largely determine the question whether the sewage discharge would be likely to become an offense to the senses or not, even considering that the sewage would ultimately become diffused, and that the water in the harbor is sufficient to safely and rapidly dilute so large a concentrated flow. If the sewage should be discharged at a uniform rate throughout the 24 hours, as has been contemplated by the Passaic Valley District Sewerage Commission, it is unquestionable that some of the sewage would be carried by the inflowing tide northwards into the Hudson and East Rivers and on the outgoing tide southward to the shores of Staten Island. If the sewage should be retained so as to have the outflow only on the ebb tide, the percentage to go northward would be greatly reduced, helping the upper harbor, but the percentage reaching the shores of Staten Island would be greatly increased; and though the total quantity of sewage in 24 hours would be no greater, it would be discharged in practically 6 instead of 24 hours; so that the quantity at any given time during the outflow would be four times as great as on a continual flow basis.

A matter of much importance in considering the dispersion of sewage is the question of the underrun of salt water beneath the fresher waters from the Hudson. The difference in specific gravity between the two waters may be as high as 2½%. There is thus an obvious tendency for the salt water to force itself up the river for a considerable distance and to remain stagnant while the fresher waters follow their way down to the sea. This tendency is more marked at low water stages in the river. It does not seem improbable, therefore, that some of the sewage discharged at from 30 to 40 ft. beneath the surface would even during a strong ebb tide for the upper layers of water encounter strong up-stream currents, and be, therefore, carried well up the bay and even some distance up the Hudson River. The full effect of this under-current is not known, but its existence has been noted and it might well almost totally vitiate the efforts to dispose of sewage from the proposed Passaic Valley trunk sewer by means of tidal carriage and diffusion. It might be, that for some years the collecting of this sewage in the potholes or basins of the bay and the river would not create a nuisance noticeable on the surface or in the great body of water, but it is certainly desirable to guard against such a possibility.

In any case, the subject is one more largely of tidal phenomena than straight diffusion, except as to the great probability of a local nuisance being created near the outlet pipes; one which, if erected, would be apparent from boats passing along the main channel to and from Kill von Kull; the ferry lines between Manhattan and Richmond, the many vessels anchoring on the west side of the main ship channel, particularly in summer, and to many of the steamers and excursion boats passing in and out of the bay.

The expert advisers of the Passaic Valley Sewerage Commission unite in the opinion that on a 24-hour outflow the diffusion of sewage would be so great immediately on its entering the waters of the bay as to create no nuisance. They are less certain as to the effect of having the discharge during the shorter number of hours so as to make more use of the ebb tide. In the latter case they think there might be trouble, in the former they estimate that there will be none; scarcely a safe ground to stand on in a vital question.

It has been practically impossible to secure exact figures as to the tidal flow phenomena, though United States Government Engineers some years ago conducted a series of observations and tests. From them and such other data as have been secured it seems probable that a quantity of water not far from 12,000,000,000 to 13,000,000,000 cu. ft. enters the Upper Bay at each of the tides per day. Of this amount, the approximate figures may perhaps be:

4,250,000,000 cu. ft. into the East River;
6,750,000,000 cu. ft. into the Hudson River;
1,750,000,000 cu. ft. into the Kill von Kull.

The areas of the tidal basins receiving this flow are approximately as follows:

Kill von Kull, Newark Bay, and the Passaic and Hackensack Rivers about 14.2 sq. miles.
The Upper Bay about 21.6 sq. miles.
The East River about 4.5 sq. miles.

While the Hudson River has a tidal area equal probably to all the others combined.

The ebb tide coming down the Hudson meets the ebb tide coming eastward out of the Kill von Kull; they both reach in and strike Staten Island between Stapleton and Clifton, at a point distant about three to four miles from Robbins' Reef Light. It then makes along the shore and traveling along the beach makes Fort Wadsworth. At this same time there is also an ebb coming from Arthur Kill (or Staten Island Sound) and Raritan River which, striking the main current, tends to throw it to the eastward again in the lower bay. In calm weather the force of the main tide through the Narrows may reach as far as Swinburne Island and Orchard Shoal. Strong winds at all times tend to deflect the currents somewhat.

The first effect of the flood through the Narrows is to strike the shore of Staten Island a little to the north of the point where the first effect of the ebb is felt. The second effect of the flood is reaching into the flats of the Upper Bay to the west of Robbins' Reef. The third is to flow into the Kill von Kull, and the fourth and final effect to flow into the Hudson and East Rivers. After the first of the flood tide also travels up on the Brooklyn side. It is probable that in calm weather the maximum effect of the flood tide is felt on the northwest side of the Upper Bay.

The tidal ebb is detected by discoloration of the water five or six miles from the outer face of the bar; sometimes even outside of Sandy Hook Lightship, but there seems to be little concentration of effect, at that distance from the Narrows.

The published Government reports give the maximum ebb velocity of the current in the Narrows at 1.5 knots and the maximum flood 1.2 knots per hour. In the Hudson River off 39th St. these figures are respectively 2.7 and 2.0 knots, and in the East River off 23d St., 2.0 and 1.8 knots. Estimating a constant velocity of discharge during the various tidal periods of the day the average ebb velocity at the Narrows would reduce to 1.61 miles per hour, the average flood velocity 1.48 miles per hour.

It is probable that most of the sewage which reaches the radius of action of the active tidal ebb flow, will ultimately be carried out of the harbor to the ocean, though taking several days in the process, but it is not so evident that all of the sewage or even that the major part of it, will reach such radius of action, so would remain in the harbor for gradual putrefaction and breaking up.

If the diffusion and rapid oxidation should not be so great as is anticipated by the Passaic Commissioners, it is not difficult to imagine the creation of a condition of affairs decidedly unpleasant to the senses, if not necessarily detrimental to health, particularly along the shores of Staten Island and in the path of many vessels.

PRESENT POLLUTION OF NEW YORK HARBOR.

The Hudson River receives sewage from many of the larger cities and towns of New York State, which it discharges into the Harbor of New York and ultimately into the Atlantic Ocean, but being affected by tidal action as far north as Albany, and the combined fresh water and tidal volumes so greatly exceeding the total quantity of sewage, no general nuisance has as yet been created, nor does such seem likely to arise in the near future. Some of the streams tributary to the Hudson do present, however, very serious conditions. The cities along the Hudson, south of Albany, are daily pouring their millions of gallons of filth into the river, but not creating as yet any noticeable nuisance, except near the outlets. To what extent this sewage undergoes organic change by the time it reaches New York Harbor is a question difficult of determination. If a complete change does not take place, so thorough a diffusion does not occur as to prevent any serious nuisance being apparent. The condition is not so certain, however, as to the outflow from the several hundred sewers entering New York Harbor at both sides of the Hudson River from the Yonkers line southward; in the various kills and bays, and in Long Island Sound within the radius of action of the harbor's tidal flow. It should be said in fairness, that at the present day the waters of New York Harbor in general are not so polluted as to be offensive to the senses, though such is the case in some of the estuaries and smaller bays.

Without elaborate study, no one can estimate with precision, however, the exact degree of pollution permissible before the conditions will reach a serious stage. The following table gives estimates of the present normal daily sewage flow from existing sewers; that proposed from the Passaic Valley trunk sewer and that from another large system lately constructed, which will accommodate South Orange and other communities in that portion of New Jersey, as well as a considerable portion of the City of Elizabeth:

From locality	Estimated present population.	Estimated daily dry-weather sewage flow, gallons.
Communities on shores of New York Harbor	4,470,000	447,000,000
Part of Elizabeth and South Orange District	80,000	8,000,000
Part of Passaic Valley District	500,000	50,000,000
Totals	5,050,000	505,000,000

On the map accompanying this report has been indicated the outlet points of all sewers of which information could be secured, the table in Appendix 2 showing their respective discharges.* Most of these accommodate storm flow as well as sanitary sewage. Ordinarily, of course, they only handle house and manufacturing wastes and some street washings; but immediately following rain storms, a great deal of additional filth from the streets reaches the harbor. The dilution at such times becomes so great, however, from the storm-flow itself, that little additional cause of trouble need be attributed to this feature of the case, though in quantity it would probably average some 350,000,000 gallons per day. The normal pollution may then fairly be considered to be the outflow of house and manufacturing wastes, rejected by about four million inhabitants of New York and neighboring communities.

The saving feature of the present discharge is that it debouches at so many different points that very thorough dilution occurs and any great localized nuisance is avoided—a condition which could not be predicted if the whole flow should be gathered into five or six outlets, each having the capacity of the proposed Passaic Valley trunk sewer.

It must be borne in mind in considering all such matters as those made the subject of this report, that the best or even average conditions are not those which govern the case, but that the worst possible conditions which may arise are those which should determine conclusions; consequently it is not the immediate plan of the Passaic Valley District Sewerage Commission which needs to be thought of as possibly dangerous, but the ultimate plan contemplated and not only with regard to the New Jersey project or projects, but concerning all sewerage works having present or proposed future entrance into New York Harbor and its bays or branches. In questions of this character, years must necessarily intervene between the initiation and the consummation of projects, so that future nuisance must be anticipated and relief measures considered many years before either the nuisance has been created or the relief can be given.

SANITARY AND BACTERIOLOGICAL CONDITION OF NEW YORK HARBOR AND ITS FISHERIES AND THE INDUSTRIES AFFECTED BY POLLUTION OF THE WATERS.

From the studies of the Commission it is evident that the present pollution of New York Bay, although not great, is distinctly measureable by chemical and bacteriological analyses, and careful studies of the relative proportions of sea and fresh waters in the bay and rivers about New York show that the sewage of New York city is not promptly flushed out to sea, except perchance during time of heavy freshets from the Hudson. The water of the incoming tide is not ordinarily much purer than the water of the outgoing tide, as noted in the Upper Bay, yet it is probable that most of the sewage now entering the harbor is disposed of in the harbor itself by the lower orders of animal and plant life found abundantly in the waters, the chief effect of the tide seeming to be the production of currents whereby the sewage becomes mixed and diffused. Without special and experimental studies it is impossible to estimate with clearness how large a proportion of sewage and other organic matter can be emptied into the harbor without killing these forms of life which now destroy it. Immediately following their destruction would unquestionably develop an intolerable nuisance. It is estimated that every 24 hours there is deposited from the sewers of New York and vicinity an equivalent of 1,047 tons of dry sludge, about one-half of which may be assumed to be organic matter.

The oyster beds of New York Bay are almost exclusively found on the southeast side of Staten Island and in Gravesend Bay. Most of these shell fish beds are now free from dangerous pollution, though some of them are found to be nearer sewer outfalls than is wise or proper.

Analyses of oysters and clams made under the direction of the Commission show that shell fish grown or immersed for some hours in polluted water, become polluted themselves. This fact is of peculiar importance, for the custom is almost a universal one of taking oysters from their natural beds and depositing them for a few hours or days in the mouths of fresh-water streams adjoining the coast; streams which are almost invariably seriously polluted, the object being to give the oysters a so-called "drink," which results in bleaching and bloating them.

Fish caught in the harbor do not seem to have given evidence of impairment of their meat due to polluting matters, except at certain times in the past from special causes, such as the outpouring of petroleum and other industrial wastes.

It is probable that about 1,000,000 bushels of market oysters and clams are taken from the waters of New York Harbor annually at an approximate valuation of only about $900,000. The fishing of importance in the same water is practically confined to the catch of shad in the very short spring season, which amounted in 1901, the heaviest year since 1888, to less than 3,500,000 lbs., valued at about $110,000. From these figures the question of interference with fisheries cannot be considered a very serious one from the industrial point of view should the whole industry disappear. Should disease, however, be disseminated from the eating of polluted shell fish before such time as the industry shall disappear from New York Harbor, the consequence might be very serious.

There have been taken during the past season about fifty samples of water from the harbor at points between the Battery and Coney Island on one side, and the Battery and Raritan Bay on the other. These were analyzed with results that colon bacillus, an invariable accompaniment of sewage, was generally indicated by the "presumptive test." These analyses were made in the Prospect Laboratory, Brooklyn, by one trained in water analysis. A few specimens were also sent for examination to the Bender Hygiene Laboratory at Albany. Some fifty-one speci-

*Map and table not given here.—Ed.

mens of oysters and clams were also taken from their natural beds and examined for the colon bacillus. The results show that wherever the waters indicated pollution, the oysters were themselves found to share in the pollution; while in general the samples taken from the localities where the pollution of the water was not appreciable, were wholesome; the samples taken from the "drinking grounds" showed greater evidence of pollution than those from the natural beds.

Chemical examination of the waters made by this Commission and by others show distinct evidence of pollution both at ebb and flood tides, particularly in the Upper Bay, though the examinations do not warrant the opinion that the water is everywhere and at all times badly contaminated, but that traces of pollution can be found after the sewage has been thoroughly commingled with the waters of the bay and has traveled miles from its point of origin. The Commission does not desire, however, to base too great importance on the analyses taken through any one year. Such analyses are rather indicative of lines of investigation than conclusive in themselves, unless the results of several consecutive years have been secured and confirmatory evidence accumulated.

Concerning other industries likely to be affected by serious pollution of the waters, it should be noted that excursion steamers carried in 1903 nearly 2,500,000 passengers to bathing beaches and day summer resorts, on or near New York Bay, where have been invested a number of million dollars which would be seriously jeopardized by increased pollution of the adjoining waters. The ferries carried during 1903 something over 200,000,000 passengers, of whom nearly 9,000,000 crossed the center of the Upper Bay. These passengers are entitled to have their trip kept free from an offensive condition of the harbor waters, which will unquestionably develop in time, if the present rate of increase in sewage flow continues and should be added to by the full proposed discharge from the Passaic Valley trunk sewer.

The nearest precedent to the construction of such a sewer as is proposed by the state of New Jersey, and the discharge of sewage at either one or several points near together is from the system of the city of Boston and metropolitan districts adjoining, where a discharge at Deer Island in Boston Harbor of about 40,000,000 gallons of sewage per day causes the waters about the outlet to be discolored over an area of approximately ¾ sq. mile. At Moon Island, in Boston Harbor, discharge of about 22,000,000 gallons of sewage in less than one hour coming from tidal detention basins discolors about 1¼ sq. miles, fully two-thirds of this area being offensive to both sight and smell. It seems possible that the sewage from the proposed outfall of the Passaic Valley trunk sewer would discolor and render more or less offensive well towards 5 sq. miles of the most beautiful and most traveled part of New York Bay, assuredly covering the water on calm days at least, with "sleek" or thin film of grease, which would probably extend to Liberty, Ellis and Governor's Islands and at times even as far as the Battery, Brooklyn and nearly the whole of the north and easterly shores of Staten Island.

The section entitled "Legislative and Reported History of the New Jersey Project," has already been summarized briefly. Under "Possible Ocean Disposal of all Sewage Wastes," the commission points out that practically all the sewage of the whole metropolitan district is discharged into the nearest tide water without treatment. It states as its belief "that the limit of the possible pollution of the harbor waters without creating a very offensive nuisance has nearly been reached," and that of the alternative measures for preventing the early creation of a nuisance, numerous purification plants and "ocean disposal," the latter is a far more promising possible solution of the problem. The report then continues as follows:

NEEDS OF THE WHOLE DISTRICT, AND DESIRABILITY OF JOINT STATE ACTION.

The Commission, from the very inception of its investigations, has been confronted with the fact that the construction of the proposed Passaic Valley sewer is only one of many similar problems demanding legislative action for the protection of the waters of New York Bay against sewage contamination.

The contention of the New Jersey Commission that because the bay is now more or less directly receiving raw sewage from 4,000,000 people, therefore an increase from 1,000,000 more should be permitted is untenable.

The bay is now an immense cesspool, which, like smaller receptacles of sewage, has a natural limit of capacity, beyond which lies danger to the health and comfort of the contiguous metropolitan district. The residents of New Jersey, who thus expected to discharge their waste through the proposed sewer, are equally interested with the inhabitants of New York city in preserving the waters of the harbor from further contamination.

The establishment of a metropolitan sewerage district has been suggested, to include all sections in both New York state and New Jersey which now or in future might sewer into the bay and its tributaries. Such a district, when authorized by joint state and federal legislation, should be under the direction and control of a permanent interstate commission, with plenary power to control the discharge of all sewers hereafter constructed, as well as the evolving of a comprehensive plan for ultimately rendering the present chaotic and systemless method of sewage disposal sanitary and suitable for all future requirements.

The necessity already exists for a central authority to not only direct, but also initiate such great public works, upon which depend the beauty and healthfulness of the approximately 450 miles of shore within the metropolitan district.

LEGAL STATUS OF NEW YORK'S JURISDICTION OVER THE HARBOR WATERS.

From an opinion by Mr. John Cuneen, Attorney General of New York, the commission concludes that the State has all needed powers for the sanitary control of the waters of the harbor. These powers originated in a treaty between New York and New Jersey, made in 1833, and approved by Congress, which gave New York jurisdiction of the waters of the Bay and of the Hudson River as far North as Spuyten Duyvil Creek.

On the subject of a Metropolitan Sewerage District comprising territory in both States, Mr. Cuneen wrote:

The legislatures of the two states could undoubtedly establish in each state, respectively, a certain district to adjoin a similar district in the other state, and give jurisdiction thereover to the courts of one or the other of said two states as to all matters pertaining to the sewerage of said district; but it would seem desirable that such possible concurrent acts of the legislatures of the states of New York and New Jersey should be first approved and ratified by an act of Congress.

CONCLUSIONS AND RECOMMENDATIONS.

These we quote in full, as follows:

(1) It unhesitatingly protests against the consummation of the present plan of construction as outlined by the Passaic Valley District Sewerage Commission.

(2) It recommends that the legislature authorize the Governor of the State of New York to appoint a Metropolitan District Sewerage Commission. This Commission should continue similar examinations to those conducted by the New York Bay Pollution Commission and should thoroughly investigate the questions from engineering and economic standpoints, and make preliminary surveys for, and estimates of cost of, a comprehensive system for ocean disposal of the sewage of the whole or the greater portion of the districts in both New York and New Jersey which are naturally tributary to New York Bay and adjacent waters. Such act of authorization should include a request that the state of New Jersey appoint a similar commission to work conjointly with that representing New York; the two commissions to cooperate in the investigations and recommendations as to a comprehensive scheme of ocean disposal for the district and to outline a course of procedure for later authoritative action by the two states, respectively, and the Congress of the United States. This Commission ought to be provided with adequate funds for examinations, surveys, analyses, plans, etc.—form for such bill presented herewith as Appendix 8.

In the event of the State of New Jersey pressing the construction of the proposed Passaic Valley sewer as planned, if such be authorized by constitutional legislation, the commission would recommend:

(3) That the Attorney-General of the state of New York be authorized and directed to bring an action in the Supreme Court of the United States against the state of New Jersey and the Passaic Valley District Sewerage Commission, upon his attention being called to any act of said State of New Jersey, or said Sewerage Commission, towards carrying into effect the construction of said proposed sewerage system.

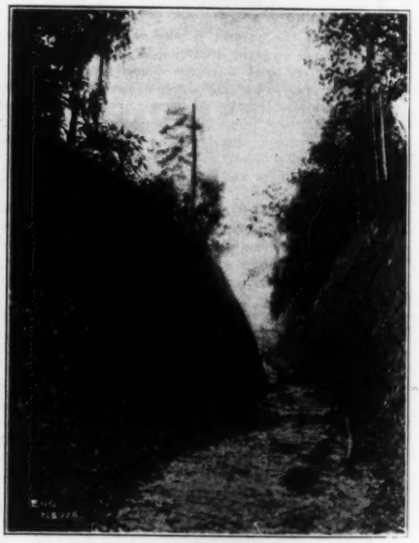
THE BRITISH NORTH BORNEO RAILWAY.

By George Cecil.*

Though it is but twenty-two years since the [Royal] Charter was granted to the British North Borneo Co., the commercial and civilizing results obtained during that period have been little short of wonderful. Although the island of Labuan was occupied by the English Government as far back as 1847, it was only when the enterprising American Consul in Brunei in 1865 procured from the Sultan of that place a cession of territory that the commercial value of the country began to be known. Seven years later Mr. W. C. Cowie, the present Managing Director of the company's railway, started the Labuan Trading Co., an institution from the inception of which one may date the country's commercial prosperity. It must be observed that at one time British North Borneo was in exceedingly bad repute, owing to the wasteful way its inhabitants had of organizing head-hunting expeditions and similar improper methods of passing the time when business happened to be dull, or other pleasures to pall. Now, thanks to the beneficent labors of the company's officers and the good missionaries, the Dyaks and other aborigines devote their days to tilling the land and working on the railway and other public works.

Roughly speaking, the island of Borneo lies to the south of China, to the north of Australia and to the east of Sumatra, being almost midway between 10° N. and 10° S. of the Equator. Provided with excellent bays and waterways, and being right on the highway of vessels trading between Europe, China, Japan, India and Australia, it is admirably adapted to commercial purposes. It has a population of about 150,000, 20,000 of whom are Chinese. The population of Sandakan, the Capital, is from 6,000 to 7,000. The minerals found in British North Borneo consist of coal, gold, iron, manganese and mineral oils.

Before the question of constructing a railway was mooted, officials and others desirous of reaching the interior could only do so by means of native boats and launches—as far as the rivers were navigable—after which the journey was continued on horseback. Later on a number of steam launches were obtained, by means of which the rate of progress was improved, and less time was wasted in transacting Government and commercial business. In 1895 a memorandum with reference to railway construction was drawn up and submitted to the authorities, it being pointed out that the land through which the proposed railway would pass was thickly populated and under cultivation. It was first proposed that the length of the line should be 50 miles, and that it should eventually be continued across the country. Although the latter hope has not been realized, [illegible]



FIGS. 1 AND 2. VIEWS ON THE LINE OF THE BRITISH NORTH BORNEO RY.

*027 Langham St., London, England.

less than 106 miles of line (including branches) have been constructed, and further extensions are in hand.

There were serious physical difficulties to contend with for about thirty miles, entailing hard work and great endurance on the part of the company's engineering department. The cost of construction has averaged about $53,000 per mile.

FIG. 3. A WORK TRAIN CROSSING A TEMPORARY BRIDGE.

Even in its incomplete state, the railway is provided with as much traffic as it can cope with, no less than 2,000 Chinese having lately migrated from China for the purpose of settling on the line. Enormous quantities of timber and sago are ready to be transported by means of the railway, and the tobacco growers in the interior will avail themselves of this means of communication with coast ports when the line is completed.

The line is of meter gage, and is provided with twenty stations, which are built of wood, and roofed with corrugated iron, or thatched. They consist of a ticket office, station master's office, a storeroom and a small waiting-room, the building being raised on piles with a view to protecting the flooring from the natural moisture of the ground. The timber is procured from the adjacent forests, and the building operations are undertaken by Chinese carpenters, directed by the company's engineers. The rolling stock consists of 10 passenger cars, 100 freight wagons and six locomotives. The officials are mostly natives, who work under European supervision, and the engine drivers, stokers and guards are of the same nationality. It is worthy of note that many of the passenger and freight cars are made at the company's workshops.

A very excellent rule of the British North Borneo Company's Railway, and one which Colonial railway companies would do well to follow, is that applying to the accepting of goods and the issuing of passenger tickets only on condition that there is room in the train, overcrowding thus being obviated. Government officers, officials and troops, however, have the preference over the public, a circumstance which is held to be advantageous to the welfare of the colony. In the event of passengers having purchased tickets before it has been ascertained that the train is full, those who have obtained tickets for the longest distance are accommodated first; those who are only going short journeys are required to wait their turn. It should also be noted that preference is given according to the order in which the tickets have been issued, and that like order is observed with regard to goods.

Passenger fares are 6 cts. per mile for first-class passengers, and 2 cts. per mile for third-class passengers.

A COMPACT BELT-DRIVEN PUMP.

It is well known to engineers that the ordinary direct-acting steam pump is quite an inefficient means of transforming power. It has the peculiarity, however, that it is small and cheap, very compact, and self-contained. These advantages are in many situations so important that they practically dictate the use of this form of pump. In particular, those cases where economy of operation is of little or no moment (as where only intermittent operation is required) present conditions favorable to the direct-acting steam pump. Quite unfavorable conditions, on the other hand, are those where space is not restricted, where operation is continuous and regular, where fairly large amounts of power are consumed, and where for these reasons steam-economy is important. Water-works pumping plants present these conditions, and it would therefore be expected that the direct-acting steam pump should be little used in water-works service. Actually, however, this form of pump is to be found very commonly in the water-works pumping stations of small cities and towns.

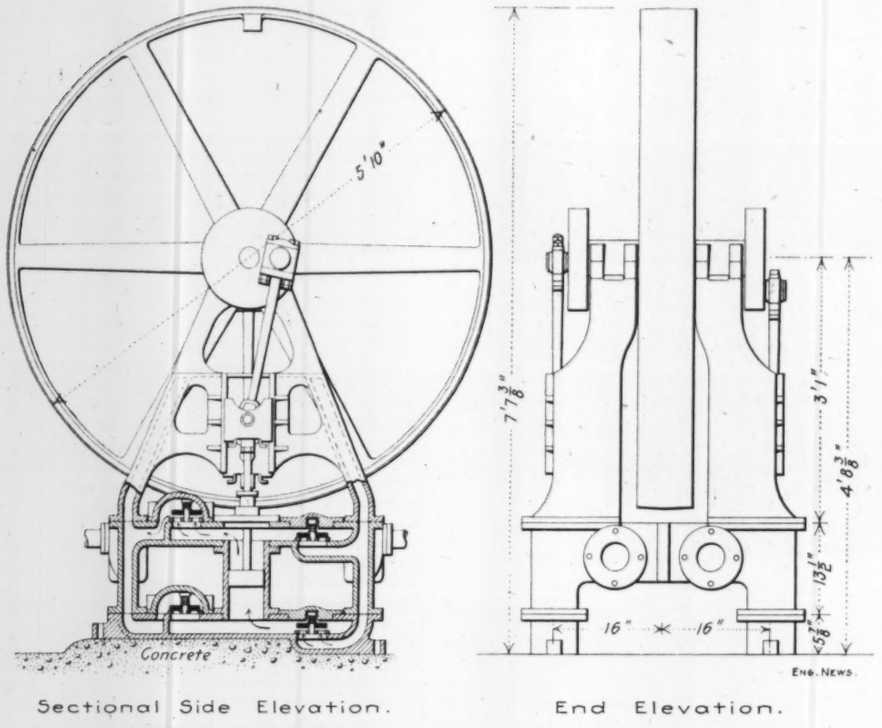
A partial explanation for this anomalous condition lies in the difficulty of designing small capacity pumps in a satisfactory way. The space required for valves, valve-chambers and passages is relatively larger as the size of pump decreases, and in very small pumps it is so large that there is much difficulty in providing for it around the pump-cylinder. In consequence small pumps, especially when made duplex or multiple so as to give more uniform delivery, often present a grouping of cylinders, valves and pipes in which the individual parts are very difficult of access for inspection and repair, and in which the component units are so intimately connected that the failure of one part will put the entire pump out of service. These observations apply particularly to the vertical cylinder type, the form generally preferred. The reliability of the pumping plant is of course materially reduced by any condition that hampers inspection or repair. Further, these pumps are usually geared from a pinion on the driving pulley shaft, and are correspondingly noisy and have lowered efficiency. Water-works superintendents are therefore attracted to the more wasteful but simpler and more accessible direct-acting steam pump.

A pump for moderate capacities which combines steam-economy with simplicity of structure and accessibility of parts was designed less than two years ago by Mr. H. F. Dunham, M. Am. Soc. C. E., of New York City. Quite a number of pumps of this design has been built, in capacities from 50,000 to 3,000,000 gallons per day, and in service they have given complete satisfaction. The novelty of the design lies wholly in the arrangement of parts, no new motion or detail being embodied in it. Partly for this very reason, however, it should engage attention. The design appears to give stability and strength of structure, good utilization of metal, simplicity of shop work, direct and ample water passages, in addition to complete accessibility of all valve-decks, bearings and stuffing-boxes. Operative economy is secured by driving directly, without gearing, from a crank-shaft, using preferably two pumps with quartered cranks; the crank-shaft may be driven by belt or rope drive from a Corliss engine, an electric motor, or the like, thus giving the pump the benefit of minimum steam consumption per unit of power consumed. The double arrangement secures several incidental advantages: only two shaft-bearings are needed, the cranks are outside or semi-cranks and are therefore accessible, the pump in normal working has an

FIG. 4. GATEWAY TO THE RAILWAY SHOPS.

equalized delivery, and in emergencies either half pump may be completely cut out without affecting the operation of the other.

The structure of the pump is fully explained by Fig. 1, showing a front elevation and a longitudinal section through one side of the pump. Considering one-half, or one unit, of the pump, the valve-chambers for the two ends of the cylinder are separate, each consisting of a longitudinal hollow beam in which is located an inlet valve-deck and valves at one end, and an outlet valve-deck and valves at the other. The cylinder stands vertically between the two valve-chambers, and communicates with the central spaces of both. Hollow extensions downward, at the ends of the upper valve-chamber, form a connection between the two inlet-chambers and the two discharge-chambers respectively. The four valve-decks are horizontal, shaped so as to form partitions across the valve-chamber. Immediately over each deck the top surface of the valve-chamber is fitted with a removable cover, through which the valves and seats can be reached.



Sectional Side Elevation. End Elevation.

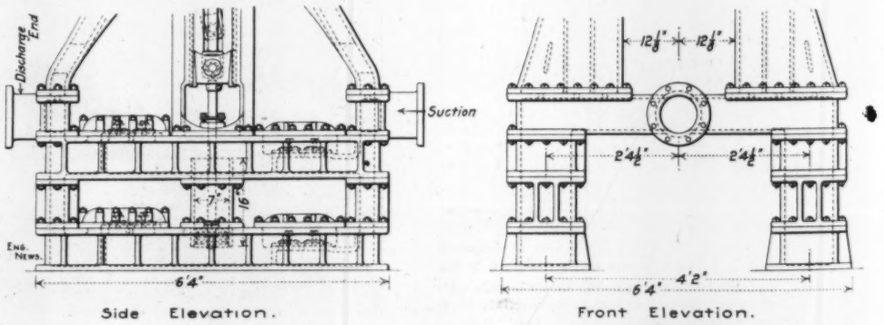
FIG. 1. ELEVATION AND LONGITUDINAL SECTION THROUGH ONE SIDE OF BETHLEHEM PUMP.

A double-acting piston works in the cylinder. Its rod passes up through a stuffing-box in the top of the upper valve-chamber, and carries a guided cross-head to which a connecting-rod is pinned, in ordinary construction.

The crank-shaft bearing on each side is supported on an A-frame rising from the upper valve-chamber, this frame having a sufficient inward batter to clear the crank-disk. Cross-bracing between the two sides is provided either by hollow cross-connectors interposed between the upper valve-chamber and the foot of the A-frame at front and rear, as in the earlier pumps of this type, or by making the upper valve-chambers of the two sides in a single casting extending around all four sides of the rectangle of the base. The latter construction, of later design, is shown in Fig. 1, while the former is illustrated by Fig. 2. In either case the cross-connectors are further utilized as mains for suction and discharge; their hollow interiors are connected directly with the respective end compartments of the upper valve-chamber on each side, and, by virtue of the passages between upper and lower valve-chambers at each end, have connection with the entire suction and discharge spaces.

In the pump shown by Fig. 2, the two units are permanently connected at both ends by this arrangement. In other pumps of this type, however, the interior of each cross member is cut by a partition at the middle as in Fig. 1, and a flanged opening is provided on either side of the partition. With this arrangement the suction and discharge pipes usually each branch into U-form before their connection to the pump, and separate valves in the two legs of either U-pipe permit one side of the pump to be shut down without disturbing the operation of the other. If, instead of combining the two discharge branches into a single pipe, the branches be kept separate, different pressures may be obtained from the two sides of the pump without decrease in efficiency. The latter feature may find frequent application in water-works piping systems which have an auxiliary storage tank or standpipe.

The pump above described has been patented, and is built by the Bethlehem Foundry & Machine Co., of South Bethlehem, Pa., in quite a range of sizes. It has been installed at Massillon, Ohio, Warren, Ohio, and Wabash, Ind., among other places, in all of which cases it is in municipal water-supply pumping service. A 1,000,000-gallon pump has been contracted for and will shortly be installed by the Crystal Water Co. in a new station at Grant City, Staten Island, New York City, also in water-works service.



Side Elevation. Front Elevation.

FIG. 2. PART ELEVATIONS OF 1,000,000-GALLON BETHLEHEM PUMP.

THE ELECTRIC STREET RAILWAY SYSTEM OF Manila, P. I., was opened to traffic on Monday, Apr. 10, 1905. The new system, comprising about forty m... track, is the successor of a horse car line about ... miles long and a steam line running to the suburb... two old lines were purchased by a syndicate several ... ago, and their conversion into a modern electric ... railway taken in hand; the firm of J. G. White & ... of New York, was in charge of the construction. The ... system has 70-lb. rail in the city (in place of the ... rail of the horse line) and 94-lb. rail in the suburb... rail was painted with asphaltum paint, on account ... severe climatic conditions. Because of the occurren... white ant, ties and sleepers are of teak in the large ... of the new line, and for the remainder of California ... wood or of Australian or Philippine soft-wood ... with preservative. The track is laid in concrete th... out. Power is supplied by a generating station loca... on an island in the Pasig River. The station has a ca...ty sufficient to operate 100 cars, and in addition to ...ply 500 arc lamps and 30,000 incandescent lamps. The roll-ing stock at present comprises 100 cars of special design. For city service the cars are open cross-bench single-truck cars, as the streets are too narrow to allow the use of double truck cars. In the suburbs double truck open and combination cars are in use. The cars have porta-ble screen partitions to separate first-class and second-class passengers. The Canadian system of fare-collection, by means of fare boxes, has been adopted. The work of construction was much hampered by the lack of supply and shop facilities in Manila, and the work was repeatedly delayed on this account. When construction was begun there was not even a machine shop in the city in which repairs could be made.

REINFORCED CONCRETE FLOORS are a feature of the new North American Cold Storage Building, near Kinzie St., Chicago, at the junction of the main and north branches of the Chicago River. The building is 16 stories high, of steel construction, with masonry walls and reinforced concrete floors and roof. The floor framing consists of 18-in. and 20-in. I-beams in one direction between columns 15 ft. apart in both directions, each line of columns being connected by 8-in. I-beams. The reinforced concrete floors of 15-ft. span are 8 ins. thick, including a finished wearing surface, and are reinforced with ½-in. corrugated bars of steel of high elastic limit. Alternate bars are bent up between the center and ends of the span, and are carried near to the upper surface of the floor at points over the I-beam girders, thence extending 2 ft. into the adjoining panels. The concrete was composed of 1 part Portland cement, 2½ parts torpedo sand, and 4½ parts crushed limestone. The bottom flanges of the I-beams were surrounded with wire netting, and the beams were embedded solidly in concrete without reinforcing. The entire concrete work from the second floor to the roof inclusive, including the protection of the columns and girders and the building of the structural floors with finished surface, was completed in the short space of four weeks. The first floor was put in later on account of the installation of machinery. The contract called for a carrying capacity of 300 lbs. per sq. ft. uniform live load, with a factor of safety of 4, stipulating that the floor should be subjected to an actual test of 1,200 lbs. per sq. ft. on any two panels. After the completion of the work, two panels were selected by the owner, and 135 tons of pig iron were placed on a space 15 × 15 ft. The two floor girders at the ends of this span were shored from beneath. With a total test load of 135 tons or 1,200 lbs. per sq. ft., there was a total deflection in the center of the span of ⅛ in., half of this being in the floor girder and half in the floor proper. There were no signs of checking or hair cracks. The load was kept upon the floor for about four hours, and a load equivalent to 1,000 lbs. per sq. ft. remained for several days. The architect was Mr. Frank B. Abbott, of Chicago, and the reinforced concrete work was designed and constructed by Mr. Alexander C. Warren, of Hoeffer & Co., Chicago.

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The International Railway Congress which assembles in Washington this week for a ten-day series of sessions was organized twenty years ago, at Brussels, Belgium, and was in fact the outgrowth of an international congress held there in celebration of the fiftieth anniversary of the establishment of railways in Belgium, and in conjunction with the Antwerp industrial exhibition of that year. Meetings have since taken place at Milan in 1887, at Paris in 1889, at St. Petersburg in 1892, at London in 1895, and again at Paris in 1900. It will be noted that the congress now assembles only once in five years, and that its present meeting is the first ever held outside of Europe.

A notable feature in connection with the Congres is that it is an official body, made up of delegates duly authorized by Governments and railway corporations in all parts of the world.

While its conclusions are in no sense binding upon the constituent members, as are the acts of our own American Railway Association and Master Car Builders' Association, yet the representative character of its membership is such that the technical work of the Congress has had a wide influence abroad.

In the United States, however, this has not been true. Until the meeting in London ten years ago the International Railway Congress had been little noticed by American railway companies. As the preponderating influence in the Congress was held by the European railways it was felt that American railway managers were not practically interested in the Congress and its work. There was a considerable representation of American railways at London in 1895, and again at Paris in 1900; but the meeting in the United States marks, we trust, the beginning of a serious attempt by American railways to place themselves in touch with the experience and practice of railways in other parts of the world. To illustrate this by figures we may note that in 1900, 22 American railway companies were members of the International Railway Congress. They appointed 48 delegates to represent them, and of these 21 were actually present at Paris. In contrast with this the official statement, dated April 3, 1905, shows that 82 railway companies of North America are now members of the Congress, and are entitled to a total of 438 delegates in it. These, in addition to the 16 U. S. Government delegates and the 8 representing the American Railway Association, make a total of 462 delegates from North America, not including the Government delegates from Canada and Mexico. The remainder of the Congress is made up of 62 delegates from foreign governments and 605 delegates representing foreign railway companies. It will be seen, therefore, that for the first time American railway companies are represented in the Congress in a fairly adequate manner.

It is quite possible, of course, that after the present year's Congress is over, the interest of American railway men may dwindle and the membership may fall off; but it is to be hoped that even though there may be some withdrawals, they may be made up by further additions to the membership. It has been urged that American railway companies ought to join the Congress in a missionary spirit, to teach our foreign friends the advantages of American method in railway work. With full appreciation of this point of view, we would emphasize the advantages to American railway companies of wider knowledge concerning foreign practice in railway working. To take only one example, we may mention the work of foreign railways in the development of motor-cars for light passenger traffic. In comparison, American railways have done nothing in this field; yet there are thousands of miles of American railway lines on which passenger traffic is now being carried on at an actual loss; and the motor-car offers a most promising method of converting this loss into a profit. So in the matters of block-signalling, the train staff system, economical fuel consumption on locomotives, and other subjects which might be mentioned, Americans can study European practice to advantage; and they may be led to do so through membership in the International Railway Congress.

The high-handed methods of the corporations which control the gas and electric supply of New York City have resulted in a legislative inquiry, and in a report to the legislature proposing sweeping reductions in the prices of both gas and electric light. The committee believes, as stated in another column of this issue, that there would be a reasonable profit on capital actually invested if the price of gas were reduced to 75 cts. per 1,000 cu. ft. and the price of electric current to 10 cts. per KW. hour, neither figures to apply in the sparsely settled portions of the Bronx or in Queens or Richmond boroughs. On the face of the evidence presented to the committee by the companies themselves, these prices appear to be reasonable, assuming that the companies are not entitled to full dividends on a grossly excessive capitalization.

The minor recommendations as to pressure, standard of purity and illuminating power and public inspection will doubtless meet with general approval. The proposition to allow New York to utilize for power purposes any available head on its water supply system is so obviously just that one can only wonder at the necessity for such legislation.

The most beneficent and unquestionably wise of the specific recommendations of the committee is the eighth and last, advising a central administrative body to control the gas and electric light and power corporations of the whole State. Had a competent body of this sort been created years ago, reckless expenditures for numerous competing works, which from the nature of things never could compete, would never have been permitted and over-capitalization of such works as were built would have been at least partially kept down. The prices and character of the gas and electric service, under a properly manned commission, would also have been regulated.

Every municipality in the State of New York needs just such a commission as the legislative committee proposes and can have it none too soon. The companies themselves, if they expect to do business on the square, need State supervision. The investing, as compared with the speculating, public is perhaps in the greater need of public regulation of light and power companies. For twenty years Massachusetts has had a Gas and Electric Light Commission, much to the benefit of all concerned. To our minds it is more important, if a choice be necessary, that the New York legislature create a commission with ample control of all the light and power companies of the State than that it reduce the gas and electric light rates in New York City.

As has been said, there are other cities than New York which need a readjustment of gas and electric rates and regulation; New York itself needs such readjustment oftener than it is possible to get it at the hands of the legislature. It is not only physically impossible for the legislature to investigate lighting abuses in all the cities and towns of the State, but it is also outside the proper function of the legislature to do such work. Legislatures are created to legislate, not to administer, and it is only when its creatures, whether public or private corporations, grossly abuse their privileges, and then but rarely, that a legislature can properly or possibly turn itself into an administrative or judicial body.

The Alumni Association of the Massachusetts Institute of Technology has issued a pamphlet, in which arguments are presented on both sides of the question as to the proposed alliance of the Institute of Technology with Harvard University. A study of the pros and cons will, we think, convince anyone who is not a graduate of the Institute or a member of its faculty that the advantages to be derived from a union with Harvard far outweigh the disadvantages. Indeed, the strongest objection to the union, and the one that continually crops up in the argument against the alliance, is embodied in the claim that "the eventual absorption of Technology by Harvard seems to be foreshadowed." Many other reasons are given as arguments against the alliance, such as these:

> The Faculty of Technology, a body of men who, both from experience and training, are as competent as any in this country or abroad to give an opinion concerning the educational advantages and disadvantages of the proposed agreement, are known to be opposed to it. . . .
>
> The proposed site is marsh land which must be filled, graded, etc., and adjoins the Stadium and athletic field of Harvard University. . . . Unless both applied and pure science are taught in the combined school, it will retrograde into an inferior technical school or become a graduate department of Harvard University. . . .
>
> It radically changes a policy that has proved extraordinarily successful for forty years. . . .
>
> The mingling of the two student bodies would seriously alter, if it did not destroy, the technology spirit of earnestness, seriousness of purpose, and devotion to work which is distinctively and universally recognized. . . .
>
> Eminent representatives of technological schools and universities here and abroad are of the opinion that schools of technology are hindered in their development by attaching them to universities.

All these arguments are well answered by the committee of three who have prepared the argument in favor of the proposed alliance. As to the dread that the Institute of Technology will become the tail of the dog—and that is apparently the overpowering fear of those opposed to the union—our own opinion is that Harvard itself has the greater cause to worry, if there is to be any worry from a fear of becoming overshadowed. With the exception of two universities, Harvard and Yale, the growth of the departments of applied science in American universities has been greater than the growth of the academic departments. At Columbia University, for example, the schools of engineering, and the professional departments generally, have long ceased to be regarded as mere appendages to "the college proper." It is, in fact, "the college proper" that might now more appropriately be termed an appendage to the professional schools. Such likewise has been the history of Cornell and of many State universities. Such will be the history in Massachusetts if its two great institutions of learning come together where the forces in one can react upon the forces in the other. Great numbers of the young men who will go to Harvard to take the classics will be attracted, either before or after graduation, into the courses in applied science offered by the combined faculties of the two institutions. The gain from an alliance, as we see it, is almost all on the side of the Institute of Technology, yet, strangely enough, the greatest resistance to the proposed union appears to have come from graduates of the Institute.

THE POLLUTION OF NEW YORK BAY.

The report of the New York Bay Pollution Commission, the substance of which we give in another column, presents some radical conclusions on the subject which gave rise to the commission and on the larger subject which that body took in hand, and it also seems ill-timed in the date of its appearance. The immediate cause of the creation of the commission was the proposed discharge of sewage into New York Bay through a large trunk outfall sewer designed to serve the lower Passaic Valley, including Paterson, Passaic, Newark and other communities. The commission condemns the proposed outlet, declares that the waters adjacent to Greater New York, Jersey City, Hoboken and Bayonne are either already or will soon be polluted to the limit of toleration, advises the formation of a New York and New Jersey Metropolitan Sewerage District, suggests "ocean disposal" for the district, and submits a legislative bill for the creation of a New York Metropolitan Sewerage Commission with power to cooperate with a similar commission in the investigation of the sewage pollution problem.

The report seems ill-timed because it appears after the adjournment of the New Jersey legislature and during the closing days of the session of the New York legislature, so that no action in accordance with its recommendations is possible for a year to come. Moreover, the New Jersey Court of Errors and Appeals has recently declared unconstitutional the act authorizing the construction of the Passaic Valley sewer, so the much-needed relief in the Passaic Valley seems little if any nearer than at any time during the ten years since active steps to abate the nuisance were first taken. Before considering the report we take pleasure in saying that we hope the present New York Commission may be continued, and that it may be given money to pursue its studies, as we understand has been suggested by Governor Higgins as the only practical action by the legislature of 1905.

Unless the appendixes to the report of the New York Commission, which appendixes are not yet available, contain stronger evidence of serious pollution, present and prospective, than is given in the report proper, we see little reason why New York should concern itself, at least for years to come, with "ocean disposal" for the whole metropolitan district and less reason for condemning the proposed Passaic Valley outfall. The only evidence in the main report that the sewage of the metropolitan district is or may become a menace to health concerns the oyster and clam industry, which it would be cheaper to buy up and abandon than to protect or perhaps only partly protect, by any practicable plan of "ocean disposal."

Besides the oyster and clam industry the main argument advanced in the report in favor of a costly system of "ocean disposal" is the protection of the waters of the bay and river from becoming offensive to the sight. It may be assumed that some of the general language of the report is intended to cover offense to the nostrils as well as to the eyes. As to the Passaic sewer outlet at Robbins' Reef, the specific argument of the report is that the grease in the sewage may give rise to a large area of "sleek," or film of grease on the surface of the bay, and also that the sewage being discharged 40 ft. or so below the surface, in salt water having a greater specific gravity than the fresh water of the Hudson, may be pushed up the bay and even the North River, depositing "in the potholes or basins of the bay and the river" and eventually giving rise to a nuisance at the surface. If this under-action took place what chances would there be for the formation of "sleek" at the surface? Would not the under-action really mean a wider diffusion of the sewage, both laterally and vertically, than would occur without it, with strong chances that not enough sewage would get far up the bay and river to do any harm?

We see little likelihood for the formation of a New York and New Jersey Sewerage District, and little, if any, need of such action. The legal talent of New Jersey has failed, thus far, to find any constitutional way of forming a sewerage district for the Passaic Valley except by the voluntary action of the several municipalities involved. Paterson will doubtless continue to fight tooth and nail any sewage disposal scheme for the Passaic Valley which may be advanced. Jersey City and the remainder of Hudson County, so far as we know, are quite indifferent to such pollution of the North River and New York Bay as now exists, and have made no protest against the Passaic Valley sewer since the outlet was changed from Newark Bay to New York Bay. Greater New York, thus far, has shown little concern about its own or its neighbor's sewage, outside of portions of the Bronx, Brooklyn and Queens. Studies for a Bronx trunk sewer, serving also adjacent territory, have already been made. Works for the partial purification of the sewage of sections of Brooklyn and Queens have been in operation for from ten or a dozen to two or three years.

We believe that for many years to come the metropolitan districts of New York and New Jersey will have many far more pressing sanitary and economic problems than those which lead the New York Bay Pollution Commission to advocate a huge scheme of ocean disposal of the sewage of the joint district. It is, however, eminently proper to look well into the future and very desirable to be satisfied that the immediate present need give no serious concern. Cooperation between the two states is far preferable to litigation, and if prompt action were possible we should be glad to see a joint commission of men thoroughly conversant with sewage disposal created and given money sufficient to make a study, the conclusions of which would be convincing to unprejudiced persons competent to form an opinion on the subject. Such a study should probably be confined to the interstate phases of the subject.

It should be borne in mind that New Jersey has had a succession of commissions on the Passaic problem, but the members of most of them have been uninformed on sewage disposal and have had little money to secure technical aid. Two commissions, however, one of the first and the present one, had able technical advisers, although but little money was available or at least utilized for their services. The conclusions of the engineers employed by those commissions were practically identical, except that the point of outfall was changed from Newark to New York Bay by the engineers of the last commission, largely on account of local popular prejudice. The present New York Commission presents but little evidence, at least in its main report, to controvert the conclusions of the engineers of the New Jersey Commission in favor of an outfall at Robbins' Reef, New York Bay. They do not seem to take into account the possibility of a partial purification of the Passaic Valley sewage, if in the future and with increased population it should become a nuisance. The possibility of this has been held constantly in mind by the promoters of the Passaic Valley sewer, but it is unlikely that it would be necessary for many years to come. Meanwhile the capital charges on the extra cost of an "ocean disposal" scheme, whatever "ocean disposal" really means, would more than pay the cost of the purification works when they become necessary, or could then be applied to "ocean disposal" if that promised to be more economical.

So far as Greater New York itself is concerned, it seems probable that minor remedial measures will suffice for most of the relatively local nuisances which are likely to occur for some years to come. Where these are not sufficient more extensive measures may be necessary, and it would be well if they could be planned with a view to fitting into some comprehensive plan for the future. Everyone who has followed the subject knows that most of the sewers of Greater New York, but more particularly in the borough of Manhattan, have been built without regard for the future of the city as a whole, and that the time is coming when extensive reconstruction is necessary. The New York Commission itself states that the multiple outlets have been the salvation of the river and bay. To our mind this general plan, even though resulting thus far from lack of plan, should be carefully studied and its possibilities of expansion by uniting and extending some of the outlets be considered before giving any serious consideration to "ocean disposal."

LETTERS TO THE EDITOR

Work of the Ohio State Geological Survey

Sir: In your issue of Apr. 13, your comment [illegible] close of the published letter from the State Geo[illegible] of Ohio, leads me to suppose you do not fully u[illegible] what our State has been doing in the way of top[illegible] work. Would say that at the same time the appro[illegible] was made for the State Geological Survey Apr. [illegible], a very much larger appropriation was made for [illegible] graphic survey of the State in cooperation with [illegible] Geological Survey. This latter work has progre[illegible] regularly each succeeding year as explained briefly [illegible] of the Preliminary Report of the Ohio Coopera[illegible] Topographic Survey, and it is expected to complete [illegible] State within five years from the present date.

Very truly yours, C. E. Sh[illegible]

Columbus, O., Apr. 26, 1905.

(We know what has been done in the ma[illegible] of topographic surveys in Ohio, and we have highly commended the work. A great deal yet rem[illegible] to be done before the whole area of Ohio is m[illegible] with contours.—Ed.)

Further Discussion of a Court Decision Relating to the Subdivision of Sections of Land.

Sir: Referring to the discussion of a court deci[illegible] relating to the subdivision of sections of land, publi[illegible] in Engineering News of Apr. 20, 1905, in which Mr. F. Hodgman, of Climax, Mich., after stating the decision of the Supreme Court of Wisconsin in the case of Underwood et al vs. Smith et al., and giving examples of its practical workings in such sections as border the north and west lines of a township, concludes, "the Wisconsin decision is bad law and should not be followed." The writer wishes to suggest that when the surveyor comes to apply the wisely constructed law his fine mathematics give way, and "a mesne course between the north and south lines of the section," as ordered by the court, will correspond exactly with Mr. Hodgman's line, which he says should be made parallel with the south line of the section, because the surveyor would place the east quarter post of the section 6 (referred to) at a point on the east line of that section, 40 chains original government measure from the southeast corner of the section, the standard for measurement being the total distance between the south and north lines of the section regardless of any meander corners which may have been placed on the east section line near the lake, except that the quarter post must fall between such meander corners if so provided by the government survey. Then a straight line connecting the west quarter post with the east quarter post so established in the lake—if a lake happens to be there—would by law be due east and west, whether it proved to be mathematically so or otherwise.

Unfortunately the government survey in Northern Wisconsin was very poorly executed (a lake often appears on the government plats when in fact there is no lake and many other discrepancies of survey equally absurd), but by law the plots are correct and such discrepancies of fact disappear. Chas. H. Gillett.

Appleton, Wis., April 22, 1905.

The Fireproof Properties of Concrete and Concrete Building Blocks.

Sir: I thank you for the attention accorded my communication respecting the fire resistive properties of concrete, in your issue of April 13. I have no desire to discredit the tests conducted by the New York Building Department or other investigators, many of which have undoubtedly been of value in demonstrating to a degree the fire resistive qualities of concrete. It seems to me, however, that the investigations will be far from complete and satisfactory until some one has demonstrated the relative fire resistance of concrete made with varying qualities of cement and sand and containing various aggregates, such as sandstone, trap rock, gravel, granite, clinkers, ashes, etc., and also has shown what thickness of concrete is necessary to safely protect steel reinforcements from heat.

These are some of the several questions which have not been fully treated in the last ten years by Engineering News, so far as I am aware, but which must be settled before the subject can be said to have been exhausted.

Regarding the fire at Estherville, Ia., cited in your comments, as an example of the ability of cement blocks to withstand fire, not all the interested observers agree with the statement quoted, as indicated by the enclosed copy of letter from the adjuster who settled the fire loss on the cement block wall. But admitting for the sake of argument that this was a good demonstration of fire resistance on the part of concrete, I beg to call your attention to the enclosed report of the experience of another building at Geary, Oklahoma, in which the result of the fire was anything but complimentary to the cement blocks. Now I do not wish to be understood as opposed to concrete either in block or reinforced monolithic style, but the two fires above noted, as well as many others

...on to indicate that there is a difference in the fire re-...ance of the material. There is no doubt that it can ...e made, and perhaps is usually made, so as to be an ex-...lent fireproof material, but it may also be poorly made ...d a failure. It would, therefore, seem to be incumbent ...on such advocates of the material as your good selves, ...d various manufacturers from a commercial point of ..., if not otherwise, to indicate to the public the best ...thods and materials to be used in order that a real ...eproof material may be obtained and not a poor imi-...ion.

...t is a pleasure to note in your last issue the interest-...g report of Prof. Woolson on tests of ordinary bricks. ...ing that so old and supposedly well known a subject ... bricks is considered fit for further investigation, I ...all indulge in the hope that your columns will not be ...osed to a further discussion of the relatively new sub-...t of concrete. Yours very truly,

Edward T. Cairns, General Inspector.
North British & Mercantile Insurance Co.

Chicago, April 19, 1905.

The enclosures sent by Mr. Cairns are given below. The first is a copy of a letter from the adjuster of the Estherville, Ia., fire to the company whose concrete blocks were used in the construction of the Davis Building. The second is a copy of a bulletin issued by the insurance company:

(1) It would please me if I might be able to reply to your valued favor of Feb. 1, commending as highly as you might wish, the hollow concrete walls in the Davis Building at Estherville, Ia., upon which I recently adjusted a small damage. I hardly feel, however, that the test was of sufficient importance to warrant my basing an opinion on the value of such walls, and would prefer to await further developments before committing myself. The fact is, that a large brick building, or at least one of its walls, crushed one of the large frame buildings which stood against the Davis Building, and on that account the burning of the frame building did not seriously menace the concrete wall. Either the falling of the brick wall or else the heat of the burning building, resulted in the cracking of the cement wall from the foundation to the top or rather the cracking of the plaster on the inside of the concrete wall in a good many places. At least that was the claim of the owner of the building. The history of the construction of this concrete wall, however, is that the foundation when being built, was crushed in by the dirt against which the wall was built, and it had to be rebuilt, and I have been wondering whether the damage really ought to have been charged to the fire. The assured claimed, however, that the cracks were not there prior to the fire, and we had to pay for them.

The chipping of the wall from what heat was thrown against it, was slight, and in a way, I regret that there was not more heat against the wall at the time of the fire, as the question of the resisting power of concrete when exposed by fire is an interesting one to the fraternity. Had the fire against this wall been more severe, its effect might have been quite noticeable. I very much regret that the circumstances do not seem to warrant my expressing a very positive opinion with regard to the value of concrete walls and partitions.

(2) PATENT STONE CONSTRUCTION.—The use of patent stone for building material, while not yet general, is becoming sufficiently common to attract the attention of underwriters and invite inquiries concerning buildings so constructed both as to weather resisting qualities, and as to fire-resisting qualities. It has been claimed that patent stone buildings deteriorate faster from the effects of weather than even a wooden building, but this has never been demonstrated. The material has not been long enough in use for much to be positively known about it. As to fire-resisting qualities, a little information may be had as a result of a fire at Geary, Okla. Ter., which occurred on May 22, 1904.

Believing that information concerning the action of fire on this comparatively untried material will be instructive and helpful to members, there is herewith presented a report on personal observations and investigations concerning the fire at Geary, as prepared and furnished to this association by Mr. C. T. Ingalls, of Oklahoma City, O. T., Manager of the Oklahoma and Indian Territories Inspection Bureau. The report follows:

Sunday, May 22, 1904, at about 4 o'clock a. m., a fire occurred in the two-story brick and "patent stone" buildings belonging to Mr. Charles Dewaide, and located on lots 29-30, block 34, Geary, O. T. These buildings were erected in 1902, the brick in June and the patent stone in October of that year. The brick building was two stories, 40 × 80 ft., and occupied on the grade floor by two store rooms. The north half, at the time of the fire, was vacant; the south half being used as a saloon. The entire second floor of this building was occupied for rooming or lodging purposes exclusively.

The patent stone building, immediately adjoining and communicating on the south, was two stories, 25 × 80 ft., and was occupied on the grade floor by a barber shop (without baths) in front, and billiard hall in the rear. The second floor was used for offices, all of which were vacant at the time of the fire.

The fire was said to have started in the back room of the second floor of the brick. Eye witnesses stated to the writer that the patent stone walls fell nearly half an hour before the brick collapsed. The party wall between these buildings was 16 ins. on the grade floor and 12 ins. on the second, and was constructed of fairly good brick.

The patent stone building was constructed of "blocks" or monoliths 30 ins. long, 10 ins. wide, and 9 ins. high. Each block has two hollow spaces 4 × 10 ins. Eye witnesses state that as soon as the roof got to burning well, the walls commenced to bulge and the blocks fell apart with reports like pistol shots, one-half of the block going one way and the other half the other. Toward the rear is a portion of the wall about 10 ft. high on the south side, and the entire rear wall up to the second story, was still standing. However, the stone in every block (including those next the ground as well as those higher up) was completely disintegrated. The portion of the wall standing is badly cracked and absolutely worthless. Not a drop of water was thrown on this building at any time. The owner of this building informed the writer that he found it necessary to coat the entire outside of the patent stone with cement, as the stone absorbed so much water that the paper and inside finish would peel off after a heavy rain.

This building was erected by the "Oklahoma Stone Manufacturing Co." of Oklahoma City. One of the officers of this company recently informed the writer that the stone in this building contained one part "Live Oak" Portland cement and five parts sand. This sand was taken from "Sand Creek" two and one-half miles north of Homestead, O. T., and is a round, pebbly sand. This officer further stated that they were now using the "Iola" Portland cement with a proportion of one part cement to four parts sand. The manufacturers of this stone also sell a machine with which to manufacture the "blocks" or "monoliths" and one of the officers of the company recently advised the writer that there were about twenty of these machines in use in Oklahoma Territory.

The conclusion which (in the writer's opinion) must be arrived at as to the fire retarding qualities of this stone is, that a building of this construction should be put in the same class with a "brick veneer." If the building at Geary had contained a heavy stock of inflammable material, and had that town a water-works system and fire department so that an abundance of water could have been used, the query is, what would have been the result of the action of water on this stone when superheated?

NOTE BY THE BULLETIN EDITOR.—A recent inspection of the plant of the Oklahoma Soap & Oil Co., at Oklahoma City, O. T., affords another illustration of the action of heat on patent stone—of which the building is constructed. The building was erected about October, 1903, (9 or 10 months ago). The walls are of patent stone. Built into, and forming a part of the wall, is a flue or smokestack, also of patent stone, connecting with an upright boiler in the boiler house. The flue is checked and deeply cracked from top to bottom, evidently as a result of heat, as the walls of the building are not cracked at any other point.

(Where resistance to fire is an important element in concrete work, the use of clinker from steam-boiler furnaces for the aggregate is generally considered best practice.

As to the fireproof qualities of concrete blocks, it is generally conceded that much of the concrete block work already done has been of very poor quality. Undue economy in the use of cement, insufficient mixing, and blocks made with so dry a mixture that the whole structure is porous, are among the common faults.

Any engineer familiar with concrete would expect such blocks to absorb water like a sponge and to easily succumb when attacked by fire.

Our correspondent's letter is an excellent illustration of the fact that there is need of more knowledge and more engineering supervision for a healthy development of the concrete-block industry.—Ed.).

ANNUAL MEETING OF THE AMERICAN ELECTROCHEMICAL SOCIETY, BOSTON, MASS., APRIL 25 TO 27, 1905.

The fourth annual meeting* of the American Electrochemical Society was held at Boston, Mass., during the three days, April 25 to 27, 1905. The attendance was rather small, there being little over 50 members present, a fair share of these belonging to Boston or Cambridge, so that the visiting membership was well below 50. The technical program offered was substantial in amount—nearly thirty papers were disposed of—but only three sessions were had, which gave insufficient time for its adequate consideration. Discussion, in consequence, was quite moderate in amount. In partial compensation the meeting gave opportunity for several interesting tours: a visit to the General Electric Co.'s works at Lynn, Mass., an inspection of the by-product coke-oven plant of the New England Gas & Coke Co., at Everett, one of Boston's attractive suburbs, and a visit to Harvard University at Cambridge. One of the three sessions was held in Pierce Hall of Engineering at Harvard, and the other two were held in the Electrical Laboratory of the Massachusetts Institute of Technology, so that the visitors were brought into close contact with two of the most noted of New England's colleges. Informal receptions to the members by President Pritchett of the Institute and President Eliot of Harvard increased the intimacy of this contact. A smoker on the evening of the first day of the meeting, and a banquet on the following evening at which Prof. A. E. Kennelly of Harvard made a distinguishing success as toast-master, were the social features of the program.

The visit to Lynn, under the guidance of Mr. Elihu Thomson and Mr. Richard Fleming, gave a survey of a great mass of interesting work. The manufacture of steam turbines in active progress, the production of dynamos, watt-meters and arc-lamps, the insulation of small-gage wire with collodion film, were among the technical processes shown. Several interesting fragments of experimental work were also exhibited; one of these was the weighing of the jet impulse on sections of steam-turbine vanes, and somewhat related was the study of steam-turbine rotation by spark illumination at every revolution. A striking exhibit of different character was a dark-room comparison of the aspect of various colored fabrics under the illumination of the arc-lamp, the mercury-vapor lamp, the Nernst lamp, etc., separately; the differences revealed by this comparison were rather astonishing.

The plant of the New England Gas & Coke Co. at Everett is a 400-oven plant using Otto Hoffmann by-product coke ovens. The ovens are arranged in eight batteries of 50, each battery served by its own charging carriage and discharging ram. Nova Scotia coal is used, being brought by vessel and unloaded by clam-shell buckets into an elevated storage bunker. A single endless cable-tramway system serves the entire plant, passing under the discharge-spouts of the main bunker, over the storage-bins of the several batteries of ovens, and alongside a storage yard from which the coal may be rehandled by a clam-shell bucket hoist. The ovens are run 30 hours, the latter half of the period yielding the gas used for heating the ovens. A particular feature is the extensive purification made necessary by the high sulphur content of the coal. The plant in normal operation consumes 1,500-1,700 tons of coal per day, and produces one-half to three-quarters—according to the coke market—of all the gas used in Boston and suburbs.

The business transacted at the meeting included, beside the election of officers, only the adoption of some minor amendments of the society's constitution. These officers were elected for the coming year: President, Prof. W. D. Bancroft, of Cornell University, Ithaca, N. Y.; Vice-Presidents, Mr. E. F. Roeber, of New York, N. Y., Prof. L. Kahlenberg, of the University of Wisconsin, Madison, Wis., and Mr. C. Hering, of Philadelphia, Pa.; Secretary, Mr. S. S. Sadtler, of Philadelphia, Pa.; Treasurer, Mr. P. G. Salom, of Philadelphia, Pa.; Managers, Prof. C. A. Doremus, of New York, N. Y., Prof. W. R. Whitney, of the Massachusetts Institute of Technology, Boston, Mass., and Mr. C. P. Townsend, of Washington, D. C.

PRESIDENTIAL ADDRESS: THE HISTORY OF THEORIES OF ELECTROLYSIS.

The Presidential address of Prof. H. S. Carhart (Ann Arbor, Mich.) was read at a special session held on the evening of Tuesday, April 25, immediately preceding the smoker. It was entitled "Revisions of Theories of Electrolysis," and presented an analytical review of the principal phases through which the theory of electrolytic action has passed in its development to the modern dissociation theory. The specific subject was introduced by a mention of the early discoveries of electrolysis. Troost and Deville discovered, just prior to 1800, that water could be made to produce hydrogen and oxygen when the electric discharge from a battery of Leyden jars was passed through it. Later, silver nitrate was made to deposit silver in similar manner. These were the earliest electrolytic observations. Rapid progress was made after Volta, in 1800, produced the dry-pile and the voltaic battery. Nicholson, in England, working with the dry-pile later in that year, decomposed water by its current, and inferred that this electrolytic action might be the general type of electric action in chemical processes. Soon after, using the voltaic battery, Cruikshank decomposed lead acetate, and as he observed that all substances which he electrolyzed contained oxygen, he set up the hypothesis that the electricity seizes on the oxygen and carries it from one electrode through the liquid to the other. This was the first theory of electrolysis, a theory which was soon demolished. Sir Humphrey Davy tried the experiment of electrolyzing a solution when his body was interposed in the circuit within the liquid; the action being the same as before, he concluded that the theory failed because obviously the oxygen was not transferred through his body. Three years later a theory was proposed which stood for full half a century. Grotthus in 1805 published his famous theory of conduction in electrolytes, a theory which remained in school-books till twenty-five years ago, although it had long been untenable and in fact was replaced by a new theory in 1857. The importance

*Seventh of the semi-annual meetings of the society.

of Grotthus' theory at the time of its promulgation was that it showed that a mechanism of electrolysis could be conceived which would explain the observed phenomena in a satisfactory way. But it was soon shown that any potential difference, however small, would convey some current through a liquid, while Grotthus' theory made conduction in an electrolyte coexistent with electrolytic separation. Yet no advance was made in electrolytic theory until 1857, when Clausius applied his study of thermodynamics to the problem. Clausius concluded that, assuming the molecule decomposable into two part-molecules, the action could not be explained from the force-standpoint if only fully-combined molecules existed in the liquid; but if one molecule were already split up into its part-molecules, moving about independently, then the action occurring would be fully accounted for. He suggested, further, that the mobilities of different kinds of part-molecules need not be the same. Suggestions for further development of this theory were made a few years later by Hittorf, but his work passed without notice. In the early 80's Vant Hoff showed a striking and thorough analogy between the osmotic pressure of a solution and the vapor-pressure of a gas. Basing mainly on this comparison, Arrhenius in 1887 set up the theory of definite dissociation in an electrolyte, advancing Clausius' ideas by the substitution of large and definite dissociation for an indefinite or unit dissociation. The theory of Arrhenius, with the elaboration of its different phases by experiment and calculation, forms the substance of the electrolytic dissociation theory of to-day.

THE REVERSIBILITY OF POLARIZATION.

The technical program was opened by a rather abstruse discussion, a paper on "Reversible and Irreversible Electrolytic Polarization," by Prof. W. S. Franklin (Bethlehem, Pa.), and L. A. Freudenberger. The paper raises the question whether the polarization of an electrolytic cell is wholly "reversible" or is in part "irreversible," and attempts an experimental answer to the question. The subject is complicated by the disagreement between different physicists as to what should be included in the meaning of polarization. The authors therefore set out with a definition of their own. The voltage consumed in an electrolytic cell may have three components: 1, the resistance drop; 2, the decomposition voltage, which may be positive as in a voltameter or negative as in a primary battery, and 3, a drop which is an unknown function of the current and is due to various irreversible actions at the electrodes. The authors call the sum of 2 and 3 the polarization, and the part 3, if existing, is the "irreversible polarization." They measured, therefore, the back voltage of a copper-sulphate cell at various currents, to determine the total polarization as a curve plotted on current. But they find that the polarization at any particular current value varies greatly within a very short period after starting or stopping current-flow, apparently reaching a maximum within about half a second, then dropping off to a constant value. The polarization at time zero is therefore difficult to determine, and the authors' work has not yet been carried far enough to indicate it. They conclude, however, that at finite current values an irreversible polarization does appear, though they have not yet obtained its value.

In discussion, Mr. Carl Hering (Philadelphia, Pa.) called attention to the lack of agreement on a definition of polarization, and suggested the influence of concentration changes at the electrodes, thermo-electric action, escape of products of electrolysis, action of products on the electrodes, etc., as complications which frequently occur. However, Prof. Franklin pointed out that these actions are eliminated from consideration by the definition adopted in the paper with the further proviso that all subsidiary actions which can be avoided or can be separately determined should be thereby removel from the problem.

THE ALUMINUM CELL CONDENSER.

A paper by Mr. C. I. Zimmermann (Pittsburg, Pa.) entitled "The Aluminum Electrolytic Condenser," gave some data on that device supplementary to the information given in a paper under the same title presented by the author at the Washington meeting of the society a year ago. The peculiar "passive" film formed on the aluminum electrode has not yet been measured except through its interference colors, giving thicknesses from 0.000,005 cm. to 0.000,050 cm. Using these thicknesses the author finds the specific resistance of the film (in one instance) to be about 10^{11} ohms per. cu. cm., the dielectric strength to be in the neighborhood of 5,000,000 volts per centimeter (which is comparable with that of mica), and the specific inductive capacity about 15. The losses in the cell may be made as low as 3 to 5%; they consist of leakage and frequency losses in the film, the internal resistance loss of the cell, and an electrolytic decomposition loss. The frequency loss in the film increases with the frequency and is generally larger than the other losses in the cell; its nature is not understood. The ratio between the direct and alternating voltages on the cell slightly differs from the theoretical relation, but proves to be linear above 10 volts; the cell may therefore be used for rough calibration of alternating-current voltmeters from a direct-current instrument. The paper also shows and analyzes the relations of voltages occurring in an "asymmetrical" cell, i. e., one in which the electrodes differ in size. The smaller electrode is subjected to the greatest pressure, this being, in the limiting case of a point electrode, twice the maximum value of the impressed alternating voltage. Mr. W. R. Mott pointed out, in discussion of the paper, that the estimation of film thickness by interference colors is open to much doubt, as the refractive index of the film and the general conditions at the surface are not known.

SOLUTION TEMPERATURES IN COPPER REFINING.

A short paper by Prof. C. F. Burgess (Madison, Wis.), entitled "Notes on Economic Temperatures of Copper-Refining Solutions," bears on a subject raised by Prof. W. D. Bancroft in a paper read at a meeting of the society two years ago. Prof. Bancroft showed among other things that with electrodes 1 cm. apart, less electric energy is consumed per unit of output if the solution temperature is raised considerably higher than in the actual practice of refineries. But Prof. Burgess in the present paper demonstrates that the beneficial effect of higher temperature is much greater when the electrodes are close together than when they are farther apart, and he implies that the economic temperature for electrolytic copper refinery is lower than that recommended by Prof. Bancroft, though the author does not make the actual calculation.

THE ELECTRODEPOSITION OF CHROMIUM.

Messrs. H. R. Carveth and B. E. Curry, in a paper entitled "Chromium and the Electrolysis of Chromic Acid" presented some experimental work on an involved subject of chemistry. The chemistry of chromium and its compounds is only partly explored, and in many of its phases great diversity of views exists. The work of the authors throws light on some of these discrepancies, and gives promise that the entire subject of chromium may be cleared up in the near future. We are here concerned mainly with the authors' success in the electrodeposition of the metal. They succeeded in securing good platings of chromium on various metals, under conditions which they are able to control quite definitely. The metal is very stable, being a rather weak chemical agent, and therefore constitutes a resistant coating for metals which are more readily attacked.

Our results prove conclusively that Placet and Bonnet (who took out a patent on the electrodeposition of chromium in 1894.—Ed.) were right in stating that metallic chromium could be obtained by the electrolysis of commercial chromic acid. We have made a large number of runs to find the effect of certain variables on the nature of the deposit. Platings made without stirring the solution and without finishing by buffing, etc., resemble the very finest work done with silver. In fact, for plating purposes the metal should have a great future before it. The average metal deposition in all our runs is somewhat over 0.1 gram per ampere-hour.

The failure of so many chemists is probably due to the use of too low current densities, combined possibly, with the belief that it could not be done.

Incidentally, the results showed that the earliest worker in the field, Geuther (1856), was right in his claim that chromium could be deposited by electrolysis, though his work was discredited by a later worker's negative results, and hence was not accepted.

ELECTROPLATING ON ALUMINUM.

A subject of similar interest to the preceding was handled in a paper by Mr. A. Lodyguine (New York, N. Y.): "Some Results of Experiments with the Electrodeposition of Metals on Aluminum." The author endeavored to plate aluminum with antimony or antimonious lead for use in storage-battery plates. He succeeded by plating the aluminum with copper, and then plating antimony on the copper; the resulting coating resists bending, heating and the like, very well. The electrolyte used for the copper plating was pure water with a few drops of sulphuric acid, and anode of pure copper being used. Thorough cleaning of the plate with acid, caustic soda, and washing and brushing in water, is necessary before starting the plating and three or four times during the process. The copper coating can be tinned, even though the thickness of copper be very small. The deposition of antimony on the copper is produced by using a concentrated solution of sodium protosulphide with excess of the latter; the anode is a carbon plate surrounded by trisulphide of antimony, contained in a porous cell. In both these plating processes a current density of about .187 amperes per sq. ft. was found best.

ELECTRIC SMELTING OF TITANIFEROUS IRON ORES.

The same author presented a paper on "Experiments with the Reduction of Titaniferous Ores," which reported complete success (up to the present only experimental) in the reduction of titaniferous magnetites, hematites and other ores of iron. He considers that these ores will ultimately become of great importance in the American iron and steel industry, provided a successful method of treating them can be found. Ores of this character are very unsatisfactory in the blast-furnace, for which reason another method of smelting seems indicated. The author refrains from describing his apparatus and methods except to say that he used a small electric furnace holding about 4½ lbs. but capable of working continuously. He gives the following specimen results to indicate how successfully he could control the product. The first column gives the analysis of the ore (Canadian) and the other three columns the analyses of three different products obtained from the same ore, by specific variations in the detail procedure:

	Ore.	Product No. 1.	Product No. 2.	Product No. 3.
Iron	50.30%	97.67%	84.70%	80.34%
Silica	4.26	....	....	....
Silicon	....	0.40	0.40	1.40
Sulphur	0.35	....	0.60	0.20
Phosphorus	0.06	....	0.08	0.09
Titanium dioxide	16.42	....	....	....
Titanium	....	tr	13.79	17.22
Manganese	0.18	....	....	....
Alumina	2.34	....	....	....
Aluminum	....	tr	....	....
Lime	1.26	....	....	....
Calcium	....	0.33	....	....
Magnesia	tr	....	....	....
Water	0.30	....	....	....
Carbon	....	some	....	....
	75.47%	98.30%	99.57%	99.25%

In producing No. 1, the loss of iron in the process was about 16.5%. The slag contained about 22% iron and 17% titanium, and the author states that ferro-titanium could profitably be extracted from it. In the experiments, the time to reduce a charge was about 8 minutes, of which about half was required to heat the furnace and its charge. The electric energy consumed was about 1.5 KW.-hrs., at the rate of 11.25 KW. The author calculates that steel could be produced by this method for about $16, and $7 realized from by-products (ferro-titanium, titanium carbide, titanium silicide and the like).

ELECTRIC REDUCTION OF LEAD OXIDES.

A third electro-metallurgical process was described by Mr. Lodyguine, under the title of "Experiments with the Reduction of Different Oxides of Lead by Electric Current." The object of the work was to recover the lead from waste lead-peroxide of old storage-battery plates. By electrolyzing the peroxide mixed with sodium chloride in a 30° B solution of sulphuric acid between lead electrodes, the reduction was accomplished. The successive stages in the reduction were: PbO_2, $PbCl_2$, $PbSO_4$, PbO, Pb_2O, Pb (spongy). Very

low current density, 0.2 ampere per square decimeter, was found most efficient, the yield being 2.1 grams per watt-hour, equivalent to an energy consumption of 435 KW-hrs. per ton.

BLAST FURNACE GAS POWER.

Mr. A. J. Rossi (New York, N. Y.) presented a paper, read only in very brief abstract, entitled "A Note on the Utilization of Blast-Furnace Gases in Connection with the Electric Smelting of Iron." In substance it is a calculation of the amount of gases (and the amount of their power) which may be expected in normal blast-furnace operation. Taking the low coke record made at the Isabella Furnace with the Gayley dry blast, about 1,700 lbs. coke per ton of iron,* the author computes that about 11,000 lbs. of gases are produced per ton of metal. These gases will have a thermal value of about 1,280 B. T. U. per pound, giving a total of about 14,000,000 B. T. U. per ton of iron produced. With half of this gas available for power purposes, and a gas-engine efficiency of 25%, this means 700 HP.-hrs. If the pig-iron production in the United States is 20,000,000 tons per year, or about 2,250 tons per hour, the power which might be produced from the waste gases is 1,575,000 HP. Even under the most unfavorable assumptions in every particular, a continuous power of over 1,000,000 HP. may be figured on. The author holds the opinion that the principal field of utilization for this power is the electric production of steel.

THE ELECTROSTATIC ORE CONCENTRATOR.

A paper by Prof. L. I. Blake (Lawrence, Kan.) on "The Electrostatic Method for Separating and Concentrating Ores" described the essential features of the mechanism by which electrostatic attraction has been utilized for the commercial concentration of ores. The ore, suitably crushed, is run over a charged roller, where the particles receive charge according to their electrostatic capacities; the different attractions between the roller and the various particles results in giving different paths of motion to the high-capacity and the low-capacity particles. This gives a preliminary separation, and by passing the tailings through a second and a third similar process a very satisfactory separation is obtained. The concentrators which have been built are about 12 × 12 × 7 ft. in size and weigh about 5,000 lbs. each. Mica-plate electrostatic generators are used for supplying the charging potential. No great difficulty has been found in running these generators continuously in 24-hour service in concentrating mills. Many difficulties arose in the actual application of electrostatic concentration, such as leakage of charge, mutual repulsion of the ore particles, the mechanical handling and feeding of highly-charged particles, etc., but the means developed for solving these difficulties were not described in the paper. Some specimen results of the machines were given. A zinc ore from Joplin, Mo., gave the results following:

	Zinc.	Lead.	Iron.
	%	%	%
Original ore	49.53	2.52	10.78
Iron product	2.92	9.92	34.44
Zinc product	61.31	tr	1.57

A Nevada chalcopyrite in garnet rock showed copper percentages as follows:

	Copper.
	%
Original ore	4.60
Heads	33.89
Tailings	0.79

COLLOIDAL SUSPENSIONS.

A striking presentation of an interesting and obscure subject, a subject of physics, strictly speaking, was made by Prof. W. R. Whitney (Boston, Mass.) in a paper on "Colloids." It was a grouping of observations on the physical, chemical and electrochemical behavior of permanent liquid suspensions. It is not exact, perhaps, to call all such cases "suspensions;" as some of them appear to be free from solid particles, being thus more like emulsions. When more is known about these substances, a division of colloid liquids into 1, colloidal suspensions and 2, colloidal solutions may become necessary, but in the present paper the author used the former term in a general sense to include all such liquids. A true colloidal suspension is permanent, the suspended matter (solid or liquid) never settles out when left to itself, and no indication of a saturation point can be noted. In general the presence of an electrolyte precipitates the suspension. All colloid liquids group into two classes, positive and negative, an electric current passed through such a liquid causing the suspended matter to travel toward one or the other electrode. Here the interesting fact is noted that two colloid liquids of opposite polarity will always precipitate each other, as an arsenic sulphide and a ferric hydrate suspension. But two liquids of the same polarity will not precipitate each other. Quantitative relations appear to exist in this precipitation, but they are of peculiar nature; the valency of that ion of the suspended material which gives its polarity to the suspension determines the amount needed for precipitation by an electrode or by a suspension of opposite polarity. The preceding applies primarily to inorganic colloidal suspensions; organic colloids, which are usually complex compounds, not as readily precipitated.

Colloidal suspensions are in general not separable by filtration. Some filters will separate one or another colloid, but not other colloids. The particles in a colloidal suspension are microscopic or ultra-microscopic in size; a ray of light passing through the liquid is polarized. Under the miscroscope the particles are seen to be in constant and rapid irregular motion, the Brownian movement.

A platinum colloid is produced by arcing between platinum electrodes in water, but the suspension is extremely delicate, and persists only in the purest water. If a substance in solution, not soluble in water, is poured into water a colloidal suspension results. A non-soluble liquid such as methyl blue produces a colloidal suspension in water. A precipitate formed in water when no electrolyte is present appears in colloidal form, as when mercury cyanide is precipitated with sulphuretted hydrogen.

Colloids play a large role in organic phenomena, in the biological field as well as in the field of industrial chemistry. Dyeing exhibits many cases of colloid action, the colloid being formed within the cloth fibers and subsequently being unable to pass out through the fiber. Blood and many other animal liquids are complex cases of colloidal suspensions. The action of precipitants or agglutinants upon these liquids is as yet but little studied.

The paper, a few points of which have here been abstracted, was illustrated by numerous demonstrations of the formation of colloids and their action.

In reply to a question by Prof. Franklin as to whether, when an electrolyte precipitates a colloid, the active ion is carried down with the precipitate, Prof. Whitney stated that it is; the filtrate is found to be acid or alkaline depending on the polarity of the colloid. The question was asked whether suspensions of very fine mud or silt in water are positive or negative colloids. The author replied that this cannot be stated generally, as it depends upon the nature of the silt; however, most of the mud suspensions he has tried proved to be negative. The silt suspension in rivers is precipitated at the mouth by the salt of sea-water, and not by the reduction of flow velocity. In reply to a further question he stated that heat has no measurable precipitative effect, provided all influence of electrolytes is eliminated.

SILICON.

The metal silicon, which occurs so abundantly in the earth's crust, and which is so important an element in cast iron, has until recently been known, as an isolated element, only in the laboratory. Recently it has been produced at Niagara Falls in the electric furnace, at vastly lower cost than by the previous laboratory methods, and it can now be manufactured in quantity provided a demand for it appears. Some information about its production by the electric furnace was given at this meeting by Mr. F. J. Tone (Niagara Falls, N. Y.) in a paper entitled "Silicon." Another paper, by Mr. A. B. Albro (New York, N. Y.), entitled "The Microstructure of Silicon and Silicon Alloys," gave some results of an extended micrographic study of the metal and its alloys with iron and copper. A large number of lantern views illustrated this paper.

Mr. Tone referred, in introduction, to the complex conditions existing in an electric furnace containing carbon and sand. Various compounds of silicon and carbon are formed at different stages of temperature in such a furnace, at other stages the carbon is transformed into graphite, and at other stages free metallic silicon appears. To yield the silicon as an end product, a very close control of temperature is necessary. The furnace developed for the purpose is constructed as follows: The container is a chamber open at the top and lined with fire-brick; in the center a vertical carbon resistor is disposed, with terminals at top and bottom. This resistor should have a large radiating surface, as it is the source of heat for the furnace. The charge is 60 parts sand ($Si O_2$) and 24 parts carbon, both finely ground and thoroughly mixed. The material feeds downward by gravity. When silicon is formed by the reduction of the sand, it moves downward into cooler zones and accumulates in the bottom of the vessel, whence it may be drawn off as desired.

The silicon thus produced is hard, crystalline, of dark silvery luster. It is between 6 and 7 in the scale of hardness, has a specific gravity of 2.34, and fuses at 1,430° C. Below 1,300° F. it does not oxidize in air, but near the fusing point it oxidizes as steel does.

It is expected that the principal utilization of silicon will be in the metallurgy of steel. Silicon may also be used in the same manner as aluminum is used in thermite. It gives slightly more heat per unit of weight than aluminum, but as it requires more oxygen the heat intensity of the mixture is lower than that of the aluminum mixture. However, silicon is cheaper and is more easily pulverized and ignited.

Silicon vapor in an atmosphere low in oxygen produces a compound which was at first thought to be Si O. The author now believes it to be a mixture of silicon with its dioxide, although it appears to form in fairly constant proportion and to show fairly constant physical properties.

Mr. H. N. Potter (New York, N. Y.) stated in discussion that at high temperatures silicon is rather easily attacked by carbon dioxide. Care must therefore be taken in heating silicon in a muffle or other apparatus where furnace gases can reach the metal. Mr. Elihu Thomson remarked that silicon can be cast from a cupola like iron, into green-sand or dry-sand molds. Granulated or powdered silicon in a tube makes an excellent resistance column, in which by simply varying the pressure a resistance variation of 1 to 500 can be produced; when the current exceeds a limiting value, however, the particles fuse together and destroy the resistance. It has been observed that silicon melted in a graphite crucible showed, after solidification, minute crystals of carborundum where it was in contact with the graphite.

The paper of Mr. A. B. Albro on Microstructure of Silicon and Silicon Alloys is so largely dependent upon the microphotographic illustrations which accompanied it that, while much interesting matter is presented therein, we are unable to give any summary of it here.

OPEN ARCS AND MERCURY-VAPOR ARCS.

Two papers on the subject of Electric Arcs were presented at the last session of the society, where they were of necessity given but hurried attention. One of these, by Prof. W. R. Whitney (Boston, Mass.), was probably intended to give a general survey of the phenomena of open arcs between carbon or metal electrodes; only a brief abstract was given, however, in connection with an exhibition of the carbon arc and several metallic arcs. The influence of the cathode in determining the nature of the arc in a majority of the cases was illustrated, and the experimental fact was noted that no relation has been found to exist between the current flow and the quantitative wasting of the cathode. This means that no "Faraday equivalent" exists, such as is characteristic of electrolytic actions.

The second paper, on "The Mercury Arc," by Mr. E. Weintraub (Schenectady, N. Y.), gave some of the general results obtained in the research laboratory of the General Electric Co. in

*The furnace charge being 10,200 lbs. coke, 24,000 lbs. hematite ore, 6,000 lbs. stone, and the blast 34,000 cu. ft. per min; production of iron 447 tons per day.

work upon mercury-vapor apparatus. Experimental demonstrations illustrated the reading of the paper. The first and important conclusion was thus demonstrated, namely, that the discharge in a mercury-vapor tube is started by and dependent upon the action of the cathode. The mercury-vapor tube has the peculiarity that the discharge must be started either by arcing between the electrodes or by a high-potential discharge, while thereafter it is maintained by a low voltage. If, now, two circuits in such a tube have a common cathode, and one of the circuits is started by any means, then the other starts instantaneously without extraneous aid; but if the common electrode is the anode, then the starting of one discharge does not start the other. Some of the subsequent deductions are as follows:

For ease and certainty of starting, the space between the electrodes must present as little hindrance as possible to the flow of ions starting from the cathode surface. The vacuum must be as high as possible; foreign gases or "inert" mercury-vapor retard or altogther prevent the starting of the discharge. A carbon filament of high resistance leading from the anode to within a short distance of the cathode facilitates the starting.

The minimum current necessary to maintain the arc may be lowered by reducing the area of cathode surface, or by having a wire of iron or platinum project above the cathode mercury surface. A tube on a 120-volt circuit may be run on a current as low as 1 ampere by these means.

The conductivity of the vapor discharge is proportional to the current; the current creates its own carrier ions, and the voltage across the arc is almost independent of the current.

The anode has little or no effect on the stability of the discharge.

The tube may be operated on alternating current if the cathode activity is by some means kept up. Numerous arrangements to this end are possible.

The phenomena observed with mercury vapor appear also with all other metallic vapors. The alkali metals have been tried, with some success, in the search for means of adding red rays to the spectrum of the discharge.

The loss of material from the cathode is either zero or very small, provided the volatilization of the mercury is eliminated. If a loss exists, it is far smaller than the Faraday equivalent.

The cathode action is not explainable by temperature effect, but is probably due to purely electrical action.

OTHER PAPERS.

Of the other papers presented at this meeting, quite a number were read by title only. The following are the papers not noted above:

"A Diaphragm Cell for the Electrolysis of Sodium Chloride Solutions," by Mr. C. P. Townsend (Washington, D. C.) The cell described, for use in producing caustic soda from common salt, is a design in which a very active circulation of the salt solution is automatically produced by the convection currents set up at the electrodes. A diaphragm separates the salt chamber from an oil chamber into which the caustic soda and the hydrogen pass. The cell has shown an ampere-efficiency well over 99%, with high degree of purity of products.

"Billitzer's Method of Determining Absolute Potentials," by Mr. H. M. Goodwin.

"Conduction in Electrolytes," by Prof. J. W. Richards (South Bethlehem, Pa.)

"An Electrolytic Switch," by Mr. W. S. Horry (Niagara Falls, N. Y.) The essential feature of the device is an aluminum electrolytic cell arranged to take the current-flow on breaking an inductive direct-current circuit. The use of the cell prevents arcing at the switch contacts and reduces the pressure rise in the circuit, thereby protecting the insulation. The switch itself requires to be of special mechanical construction to make the proper connections.

"The Edison Storage Battery," by Mr. M. De K. Thompson, Jr. Curves of single potentials of the two electrodes throughout the whole cycle of charge and discharge, for various strengths of electrolyte, were shown. The paper throws light on the chemical actions in the cell.

"The Electrolytic Precipitation of Silver," by Mr. R. C. Snowdon (Ithaca, N. Y.) Some experimental results on factors affecting the nature of the deposit in silver-plating.

"The Interdependence of the Atomic Weights and the Electrochemical Equivalents," by Prof. A. Reuterdahl (Providence, R. I.) In this paper some rather involved hypotheses on the constitution of matter are submitted. A convenient polar diagram is shown in which atomic weight is represented by angle, while radius vector represents ampere-hours per gram per unit of valence; all elements then take positions on a hyperbolic spiral.

"Treating Low-Grade Ores and Tailings by Electrolysis," by Mr. E. Fahrig. Read by title.

"The Specinc Inductive Capacity of Oleic Acid and its Salts," by Prof. Louis Kahlenberg (Madison, Wis.) Read by title. The dielectric constant of oleic acid was found to be from 2.50 to 2.60. Ferric, aluminum, sodium, lead, and copper oleate gave 2.68, 2.40, 2.75—2.83, 3.27—3.70, and 2.80 respectively. Cotton-seed oil, colza oil, corn oil, olive oil, rape-seed oil, palm oil, showed constants from 2.30 to 2.70. Linseed oil gave 3.25.

"The Heat of Solution of Aluminum Bromide in Ethyl Bromide," by Mr. H. E. Patten.

"The Rotating Diaphragm," by Prof. W. D. Bancroft (Ithaca, N. Y.) If a graphite rod is interposed between the electrodes in a copper sulphate electrolyte, and a fairly large current sent through the cell, copper deposits on one side of the graphite and oxygen is set free on the other. If the rod is now turned halfway, the copper is re-dissolved. If the rod is rapidly rotated, no polarization (and no deposition of metal) occurs at the graphite surface. The graphite rod under these circumstances is an ideally-reversible electrode, that is, it is at the potential of the liquid immediately adjacent.

"The Electrolytic Precipitation of Nickel on Nickel," by Mr. R. C. Snowdon (Ithaca, N. Y.) Read by title. The paper reports experiments which show that the impossibility under ordinary circumstances of plating nickel on an old nickel-plated surface is due to a "passive state" of the surface, probably a film of oxide, which can be removed by treatment with a reducing agent, as making the plate the cathode in a hydrochloric acid bath. A smooth and perfectly adherent deposit of nickel on old nickel-plating was obtained by this means.

"A Low-Voltage Standard Cell," by Prof. G. A. Hulett (Ann Arbor, Mich.) Read by title.

"An Optical Method for Observing Diffusion in an Electrolyte," by Mr. C. Hambuechen (Madison, Wis.) Read by title.

REPORT OF LEGISLATIVE COMMITTEE ON NEW YORK GAS AND ELECTRIC LIGHT SERVICE.

Sweeping reductions in the price of gas and electric service in all but the sparsely settled portions of Greater New York have been recommended by a committee of the New York legislature, which recently spent several weeks in New York City investigating the local light and power situation. The committee has also recommended that the city be authorized to develop electric current from the water power available in connection with its present or future water supply. A more general recommendation than those just named is one for a State Gas and Electric Light Commission. Bills for carrying these various recommendations into effect were introduced in the legislature on Monday of this week, but it is uncertain whether any or all of them can be passed in the hurried closing days of the session. If a determined effort to pass the bills is made a bitter fight on the part of the gas and electric light interests and the supporters of the bills is promised.

The recommendations of the committee, in more detail, are as follows:

(1.) That the price of gas sold in the boroughs of Manhattan and Brooklyn and in that part of the borough of the Bronx west of the Bronx River, should be fixed at a maximum of 75 cts. per 1,000 cu. ft.

(2.) That the pressure of gas in any of the street mains should not be permitted to exceed 2½ ins. or to be less than 1 in.

(3) That the standard of purity and of illuminating power of gas be fixed.

(4.) That a proper system of inspection be provided to secure the enforcement of the law with reference to pressure, purity, illuminating power, and accurate measurement of the gas delivered.

(5.) That the price of electric current for heat, light, and power purposes in the boroughs of Manhattan and Brooklyn, and in that part of the borough of the Bronx, west of the Bronx River, should be fixed at a maximum of 10 cts. per KW. hour of current actually consumed, and that provision should be made for inspection to secure accurate metering.

(6.) That the price of arc lamps for street lighting in the city of New York should be fixed at $100 per lamp per year for single lamps of 2,000 c. p., consuming 450 watts at the arc, and that the price of twin arc lamps, consuming 250 watts each at the arc, should be fixed at $65 each per year.

(7.) That the city of New York be given authority to utilize water power, now owned, or hereafter required, by it for the purpose of generating electric current for the use of the municipality, provided that no additional water shall be used for said purposes that would otherwise be required by the city.

(8.) That provision should be made for the creation of a commission, the members of which shall be appointed by the governor with the consent of the Senate, to be paid by the State, and have general supervision of all persons and corporations having authority to lay or erect and maintain wires and pipes for the purpose of furnishing gas or electricity for light, heat or power, with power to investigate and ascertain the character of the service and reasonableness of charges and the methods employed in manufacture and distribution and in the maintenance of works and distributing systems, and to enforce the provisions of law applicable thereto; to prescribe methods of keeping accounts; to examine the corporations under its supervision; to require annual reports, to examine books and papers and compel their production; to subpoena witnesses and to take testimony; to supervise issues and increases of securities, investments in stocks, the stocks or bonds of other companies, and transfer of franchises, and to regulate rates within the limits prescribed by law. It should be provided that the orders of said commission in confirmation by the Supreme Court at Special Term shall be enforceable by punishment for contempt in case of disobedience.

In the lengthy report embodying these recommendations the committee advances many arguments, accompanied by figures, in support of its conclusions. It is confident that the rates named would meet the cost of manufacture and distribution and provide "a reasonable return" on the capital actually invested in the production of gas and electric light and power.

On the subjects of franchises and of State supervision the report says:

FRANCHISES.—As has been noticed, serious questions are presented as to the extent to which the companies are entitled to use the streets of the city. This is a matter peculiarly within the control of the city authorities, and the validity of the franchises that are claimed is a subject for judicial determination. No action by the Legislature is recommended, as the laws already in force, if properly invoked by the local authorities, are adequate to meet the demands of the situation.

SUPERVISION OF PUBLIC SERVICE CORPORATIONS.—It is manifest that the conditions disclosed by the testimony make it necessary that the operations of companies supplying gas and electricity, as well as those engaged in other public service, should be the subject of constant and effective supervision by a body paid by the state and clothed with power to execute its orders, subject to suitable review by the courts upon appeal. The gross abuse of legal privilege and overcapitalization, and the manipulation of securities for the purpose of unifying control and eliminating all possible competition, show clearly that there can be no effective remedy by general legislation or through ordinary legal proceedings, and that for the protection of the public there should be created a commission with inquisitorial authority, competent to make summary investigations of complaints, to supervise issues of securities and investments in the stocks and bonds of other companies, to regulate rates, and to secure adequate inspection, and otherwise to enforce the provisions of law.

The history of the subway companies affords an apt illustration of the futility of carefully phrased contracts executed in pursuance of express legislation in the absence of an effective scheme for regulation. The failure of general provisions prohibiting the consolidation of corporations is conspicuously shown by the manner in which the provisions of the charter of the New York Mutual Gas Co. and the act of 1866 regarding the Standard Gas Light Co. has been evaded. The investment of millions in securities earning no dividends, and intrinsically worthless, solely for the purpose of monopoly control, points to the necessity of strict supervision in this regard. The plan of providing a commission paid by the state and invested with ample power has worked most satisfactorily in other states, and there is every reason to believe that a similar plan put in operation here will prevent the mischiefs revealed in this investigation.

Brief editorial comment on the report may be found elsewhere in this issue.

ANNUAL MEETING OF THE NATIONAL MUNICIPAL LEAGUE.

The eleventh annual meeting of the League was held in New York City on April 25 to 28. The program was of the usual high character, considering which and the fact that the meeting was held in such a large center of population the attendance at the various sessions was disappointingly small. But the attendance is rarely if ever large, and the

ork of the League cannot be measured by count- heads. The organization, more than any other voted to municipal affairs, is a creative body, d does its best and most lasting work by com- ittees: Thus it produced "The Municipal Pro- ram," which is really the framework for the gislation and constitutional enactments neces- ary for model city charters; and thus its resent committees on Uniform Municipal ccounts and Statistics and on Instruction in Mu- icipal Government and the newly created com- ittee on the Relations Between Municipalities nd Franchise Committees are extending this con- structive work. The League continues, however, its destructive criticism, passing in review year after year the shortcomings and misdeeds of a number of cities. It also utters commendatory criticism.

The reviews of municipal retrogression and pro- gress this year included the usual resume of mu- nicipal happenings during the year by Mr. Clinton Rogers Woodruff, the secretary; and also papers on Canadian municipalities, municipal conditions in Minneapolis, and the unique "Recall" system of Los Angeles. Under this system the voters can not only place a man in office but they can also put him out in case they think he has proved him- self unworthy. During the past year the recall was used once in Los Angeles.

The greater part of one forenoon was devoted to instruction in municipal government, including grammar and high schools, colleges and universi- ties. It appeared that in one way or another such instruction is being given in many secondary schools and in a number of colleges. During the past year students in eight universities have con- sidered the relation between the municipality and the street railway service. The electric light and gas service is next in order.

At the session devoted to uniform municipal accounting a progress report was submitted by the chairman of the committee on that subject, Dr. Edward M. Hartwell, City Statistician of Bos- ton. Dr. F. A. Cleveland, an expert accountant, read a paper on the terminology of accounting. "The Nature and Aims of State Control" of ac- counting was presented by Le Grand Powers, of the U. S. Census Bureau, while other papers deal: with the legal, political and administrative as- pects of state control. It was pointed out by the various speakers that intelligibility, uniformity and publicity of municipal accounts are essential to the best municipal progress and to judgment by the citizen of the efficiency of the government of his own municipality, and that these can be se- cured only by central supervision. Central ad- ministrative control, instead of being contrary to the principle of home rule, really furthers that de- sirable end, since it diminishes the occasion for legislative interference; that is, with a central administrative body, the legislature can lay down in municipal charters the broad policy of the State as regards municipal affairs, and leave the cities and towns to work out the details in ac- cordance with their local needs and desires. To ensure a compliance with these broad general principles, and the intelligibility and uniformity of the information regarding municipal affairs which should be available to every citizen, central supervision is required, and this can be obtained only by a fairly permanent staff of trained men, which cannot be found, as everyone knows, in a State legislature.

Of the many other subjects discussed, mention will be made of only two. Dr. John B. Roberts, who came from Philadelphia, and should know, summarized "The Real Cause of Municipal Cor- ruption" as corporate greed fostered by personal selfishness and indifference. In a paper which met with prolonged applause, Mr. John Martin compared "Municipal Thrift in European and American Cities," showing how extensively, and, as he claimed, profitably, municipal ownership is practiced in Great Britain and Germany, and how little municipal ownership, aside from water- works, there is in the United States. A large part of this paper was an arraignment of the New York Rapid Transit Commission for its ultra conservatism towards municipal ownership, and its great anxiety, as the speaker alleged, to make and keep a great monopoly in the hands of the Belmont syndicate.

ENGINEERING MATERIAL PRICES.

(These prices will appear in the first or second issue of each month.)

TRACK FASTENINGS—
Chicago—at mill—Angle bars, 1.40 to 1.50 cts.; spikes, 1.70 to 1.75 cts.; track bolts, 2.40 to 2.50 cts.

RAILS, STEEL—
New York—at mill—New standard sections, $28; light rails, $23 to $26; old iron, f. o. b. New York, $21 to $22; old steel, rerolling lengths, $15.50 to $16.50; old steel, short pieces, $15 to $15.50; relayers, $20 to $21.
Chicago—at mills—New, $28, standard sections; light rails, $24 to $27; old iron, $19.50 to $20; old steel, 4 ft. and over, $15 to $15.50; old steel, less than 4 ft., $14 to $14.50; heavy relayers, $22.50 to $23; heavy relayers for side tracks, $20 to $20.50.
Pittsburg—at mill—Standard sections, $28.

STRUCTURAL MATERIALS—
New York—at tidewater—Beams, channels, angles and zees, 1.74½ to 1.84½ cts.; tees, 1.79½ to 1.89½ cts.; bulbs, angles and deck beams, 1.84½ to 1.94½ cts.
Chicago—Beams and channels, 3 to 15-in., inclusive, and angles 3 to 6-in., ¼-in. and heavier, 1.76½ cts.; tees, 3-in. and over, 1.81½ cts.
Pittsburg—Beams and channels, up to 15-in., 1.60 cts.; over 15-in., 1.70 cts.; angles, 3 × 2 × ¼-in. thick up to 6 × 6-in., 1.60 cts.; angles, 8 × 8 and 7 × 3½ ins., 1.70 cts.; zees, 3-in. and larger, 1.60 cts.; tees, 3-in. and larger, 1.65 cts.

PLATES AND SHEETS—
New York—at tidewater—Sheared plates, carload lots, tank, 1.74½ to 1.84½ cts.; flange, 1.84½ to 1.94½ cts.; marine, 1.94½ to 2.04½ cts.; fire box, 1.94½ to 2.10 cts.
Pittsburg—Tank, ¼-in. thick 6¼ to 14-in. wide, 1.50 cts. at mill, Pittsburg; flange and boiler steel, 1.60 cts.; marine and ordinary fire box, 1.70 cts., at mill, Pittsburg; locomotive fire box, 2 cts.

MERCHANT STEEL—
Chicago—Machinery, smooth finished, 1.91½ cts.; tire, smooth finished, 1.86½ cts.; railway spring, 1.86½ cts.; crucible tool, 6½ to 8 cts.; special tool, 13 cts. and up.
Pittsburg—Open hearth spring steel, 2.25 to 2.50 cts.; tire steel, 1.65 to 1.75 cts.; smooth finished machinery steel, 1.75 to 1.85 cts.; tool steel, ordinary grades, 5¾ to 8 cts.

Iron—
Pig Iron:
New York—No. 1 X Foundry, $17.25 to $17.75; No. 2 X Foundry, $16.75 to $17.25; No. 2 Plain, $16.25 to $16.75; Gray Forge, $15.25 to $15.75; Basic, $16.25 to $16.75; Southern No. 1 Foundry, $17.00 to $17.50.
Chicago—Lake Superior Charcoal, $18.50 to $19; Northern Coke Foundry, No. 1, $17.75 to $18; Northern Coke Foundry, No. 2, $17.25 to $17.50; Northern Coke Foundry, No. 3, $16.75 to $17; Northern Scotch, $18; Ohio Strong Softeners, No. 1, $18.80 to $19.30; Ohio Strong Softeners, No. 2, $18.30 to $18.80; Jackson Co. and Ky. Silvery, 6% Silicon, $19.80; Jackson Co. and Ky. Silvery, 7% Silicon, $21.30; Jackson Co. and Ky. Silvery, 8% Silicon, $22.30; Jackson Co. and Ky. Silvery, 10% Silicon, $23.30; Southern Silvery, 4 to 6% Silicon, $18.65 to $19.65; Southern Coke, No. 1, $17.65 to $17.90; Southern Coke, No. 2, $17.15 to $17.40; Southern Coke, No. 3, $16.65 to $16.90; Southern Coke, No. 4, $16.40 to $16.65; Southern Coke, No. 1 Soft, $17.65 to $17.90; Southern Coke, No. 2 Soft, $17.15 to $17.40; Southern Gray Forge, $16.50 to $16.75; Southern Mottled and White, $15.90 to $16.15; Malleable Bessemer, $17.50; Standard Bessemer, $18.30 to $18.80; Alabama Basic, $17.65; Virginia Basic, $17.65.
Pittsburg—Foundry iron, Northern, No. 2, $16 at furnace; Northern forge, $14.75; at Valley furnace, $15.60, Pittsburg; Bessemer and Basic, $15.50; Valley furnace, $16.35, Pittsburg.
Cast-Iron Pipe:
New York—Carload lots, net tons, 6 to 8 ins., at tidewater, $28 to $28.50.
Chicago—4-in. water pipe, $29; 6-in. and larger, $28, with $1 extra for gas pipe.

MISCELLANEOUS MATERIALS—
Asphaltum:
Ventura and other California asphalts, $20 to $21 per ton at New York; Trinidad refined, $25 to $30 per ton; Venezuela asphalt, $25 to $30 per ton; Bermuda asphalt, $25 to $30.
Cement:
Rosendale, in wood, $1; Portland, domestic, $1.70 to $1.80; Foreign brands, $2.25 to $2.50.
Copper:
Lake, 15 cts.; electrolytic, 15 cts.; casting, 14.75 cts.
Lead:
New York, spot, 4.50 to 4.60 cts.
Spelter:
New York, spot, 5.80 cts.
Tin:
New York spot, 29.85 to 29.90 cts.

LUMBER—
New York, wholesale prices:
Piling—Spruce, ordinary cargoes, 6 to 7 cts.; oak, 14-in. butt, 40 to 50 ft., 19 cts.; 50 to 55 ft., 22 cts.; 55 to 60 ft., 23 cts.; 60 ft. and up, 25 cts.; pine, 60 to 65 ft., $8.50; 70 to 75 ft., $10.50; 80 ft. and up, $16.
Railroad ties—Yellow pine, 6 × 9 ins. × 8 ft., 58 to 59 cts.; 6 × 8 ins. × 8 ft., 53 to 54 cts.; 7 × 9 ins. × 8 ft., 64 to 65 cts.; 7 × 8 ins. × 8½ ft., 59 to 61 cts.; 7 × 9 ins. × 8½ ft., 64 to 66 cts.

NOTES FROM THE ENGINEERING SCHOOLS.

ARMOUR INSTITUTE OF TECHNOLOGY.—A series of courses for the summer session, June 26 to Aug. 4, have been arranged, and are explained in a pamphlet issued by the Institute, at Chicago. The courses include civil, mechanical, electrical, chemical and telephone engineering, shop work, drawing, mathematics, physics and manual training. These summer courses are of special advantage for teachers, and for the students of the Institute's correspondence school. There will also be special courses in shop work and laboratory practice for mechanics and apprentices. Further information may be obtained from the Dean of Engineering Studies, Armour Institute of Technology, Chicago.

A GAS EXPLOSION IN A MINE near Du Bois, Pa., April 27, killed 13 men. The men were working in the shaft of the Jefferson & Clearfield Coal & Iron Co.

A TORNADO IN TEXAS, April 29, killed 30 people, and blew down more than 150 houses at Laredo. Fifty railroad cars were blown from the tracks. Trees, fences and telegraph poles were overturned.

THE FALLING OF A MINE CAGE at the Conyngham Mine of the Dalaware & Hudson Co., at Wilkesbarre, Pa., April 26, killed 10 men. The men were being lowered into the mine, and when 350 ft. from the surface the rope broke, and the cage fell 400 ft. It is stated that, in view of the recent happening of several similar accidents, the State Mine Inspector has ordered the testing of all safety appliances on mine cages in Pennsylvania. The test will consist in drawing the pins so as to let the cages fall.

A SWING BRIDGE span at Houghton, Mich., crossing an arm of Portage Lake, was knocked off its pier by the steamer "Northern Wave," on April 15. The vessel was the second or third to reach the drawbridge this season. The customary signal for the draw to open is four blasts of the whistle while three blasts indicates that the boat will stop at the dock. The bridge-tender claims he only heard three blasts and expected that the boat would stop at the dock and when she did not stop he was unable to open the draw in time to avert the collision. The base casting on the pivot pier was shoved to one side, shearing off the six anchor bolts by which it was secured to the concrete. The whole span then tipped over into the Lake. The steamer was little injured.

PERSONAL.

Mr. R. Sterling has been elected City Engineer of Wardner, Idaho.

Mr. T. G. Elbury has been reappointed City Engineer of Hutchinson, Kan.

Mr. Joseph W. McNeil has been appointed City Engineer of Alpena, Mich.

Mr. Robert L. McAlpine has been elected City Engineer of Kansas City, Kan.

Mr. Frank Gridley has been appointed Assistant City Engineer of Troy, N. Y.

Mr. Samuel A. Gailey has been reelected Superintendent of Water-Works of Altoona, Pa.

Mr. John Burns has been appointed Superintendent of the Water Department of Titusville, Pa.

Mr. M. L. Lynch has been appointed Chief Engineer of the Southern Illinois & Missouri Bridge Ry.

Mr. A. E. Baynes has been appointed Assistant Engineer of the New Orleans & Northwestern R. R.

Mr. Bert C. Crowell has been reappointed Superintendent of the Water Department of Methuen, Mass.

Mr. Alonzo Kendall, of Medford, Mass., has been appointed Superintendent of Highways of Lenox, Mass.

Mr. G. H. McDonough has been appointed Signal Engineer of the Cleveland, Cincinnati, Chicago & St. Louis Ry.

Mr. Jas. H. Sloan, of Montana, of the U. S. Reclamation Service, has been transferred to Mr. C. C. Babb at Browning, Mont.

Mr. W. K. Walker has been appointed Division Engineer of the Missouri Pacific Ry., with headquarters at Pueblo, Colo.

Mr. W. H. Purdy has resigned his position as Assistant Engineer Maintenance of Way of the Wabash-Pittsburg Terminal Ry.

Mr. Geo. F. Richan, C. E., is now Chief of party on Grand Trunk Pacific Ry., with headquarters at Rat Portage, Ont.

Mr. Oscar Lowinson, Architect and Engineer, has removed his offices from 29 West 42d St. to 18 East 42d St., New York City.

Mr. Cary T. Hutchinson, M. Am. Inst. E. E., Consulting Electrical Engineer, has removed his offices from 56 Pine St. to 60 Wall St., New York City.

Mr. C. A. Bradley has been appointed Division Engineer of the St. Louis, Kansas City & Colorado R. R., succeeding Mr. Ralph Budd, resigned.

Mr. J. Wm. Link has accepted a position as Assistant Engineer on Water Purification and Sewage Disposal in the Department of Public Service of Columbus, O.

Mr. Robt. O. Hayt, of New York, has been appointed Assistant Engineer in the U. S. Reclamation Service, and left Washington April 27 for Billings, Mont., to report to Mr. H. N. Savage.

Mr. Joseph M. Birmingham has been reelected President and Superintendent of the Water Board of Hartford, Conn. Mr. W. E. Johnson has been appointed Engineer in charge of reservoirs.

Mr. John G. Parke, formerly Chief Construction Engineer at the Donora Works of the Carnegie Steel Co., has

resigned that position to become Chief Engineer for the Passaic Steel Co., Passaic, N. J.

Mr. Alfred L. Coupe, of Massachusetts, has received an appointment as Engineering Aid in the U. S. Reclamation Service, and has been ordered to report at Billings, Mont., for duty under Mr. W. E. Swift.

Mr. David B. Rushmore, formerly with the Stanley Electric Mfg. Co., Pittsfield, Mass., is now connected with the Railway Engineering Department of the General Electric Co., Schenectady, N. Y.

Mr. A. H. Perkins has received an appointment as Engineer in the U. S. Reclamation Service by transfer from the Philippine Service, and has been ordered to report to Mr. Babb at Browning, Mont.

Mr. Olaf Hoff has severed his connection with the New York Central & Hudson River R. R. as Engineer of Structures, and is now connected with Butler Bros. Construction Co., 1170 Broadway, New York.

Mr. Irwin B. Hosig, of Wisconsin, has been appointed Hydrographic Aid in the U. S. Reclamation Service, and has been ordered to report to Mr. S. B. Robbins, Great Falls, Mont. Mr. Hosig graduates from Wisconsin University this spring.

Mr. S. G. Swigart, until recently with the Pere Marquette R. R., has been appointed Assistant Engineer in the Construction Department of the Cincinnati, Hamilton & Dayton Ry., with headquarters at Dayton, O., in charge of the North and South Divisions and branches.

Mr. Charles J. Cottee has been appointed Superintendent of the newly formed Production and Accounting Department of the Otis Elevator Co., Yonkers, N. Y. This department will assume the duties heretofore performed by the Stock, Order, Accounting and Cost Departments.

Mr. J. Francis Le Baron, M. Am. Soc. C. E., has been appointed Consulting Engineer of the British Honduras Deep Water Docks & Railway Co., and has been requested to make an immediate examination and report on the proposed new harbor that the Imperial Government proposes to build in British Honduras.

Mr. Waldo S. Coulter, of Massachusetts, has been appointed Assistant Engineer in the U. S. Reclamation Service, and has been assigned to duty at Ft. Laramie, Wyo. Mr. Coulter has had a varied experience in design and construction of highways, culverts, reservoirs, earth dams, pile driving, sewers, etc.

Mr. Ernest J. Fisher, of Wisconsin, has been appointed Engineering Aid in the U. S. Reclamation Service, and will report for duty to Mr. Cyrus C. Babb, Browning, Mont. He is a graduate of the University of Wisconsin, and has held a position as Locating Engineer for the Despatch Construction Co., Chicago.

Mr. Paul Rothi, of Minnesota, has been appointed Engineering Aid in the U. S. Reclamation Service, and will report to Mr. S. G. Porter, Mitchell, Neb. Mr. Rothi was graduated from the University of Minnesota with the degree of C. E., and has been employed by the Chicago, Milwaukee & St. Paul R. R. Co.

Mr. Guerard, Inspector General of Bridges and formerly Engineer-in-Chief of Marseilles Harbor, has been named by the French Government as its member of the board of advisory engineers of the Isthmian Canal Commission. The German Government has named Herr Heins Tincanza as the representative of the German engineers on the board.

Mr. Andrew B. Larson, of Utah, has been appointed Engineering Aid in the U. S. Reclamation Service, and has been assigned to duty at Salt Lake, Utah, under District Engineer C. L. Swendsen. Mr. Larson was graduated at the Agricultural College, Logan, Utah, as B. S. in C. E. and has been employed in surveying with U. S. Deputy Surveyor and under the R. G. W. Ry. Co.

Mr. Philo Holbrook, Jr., Assistant Engineer in the U. S. Reclamation Service, will report for duty to Mr. T. A. Noble, Spokane, Wash. Mr. Holbrook is a graduate of the University of Oregon and has had a great deal of experience in surveying and irrigation work. He recently terminated a temporary position under Mr. Noble, who highly recommended his permanent appointment.

Mr. Jos. I. Bingham, of Wisconsin, has been appointed Engineering Aid in the U. S. Reclamation Service, and ordered to report to Mr. Cyrus C. Babb, at Browning, Mont. Mr. Bingham is a graduate of the Starkey Seminary, Lakemont, N. Y., with the degree of C. E., and at present is a senior in Wisconsin University. He has had practical experience in connection with the Lehigh Valley R. R. Co.

Mr. Geo. H. Stroebe, of Michigan, has received an appointment as Engineering Aid in the U. S. Reclamation Service, and has been assigned to duty at Bismarck, N. Dak., under Mr. James E. French. Mr. Stroebe is a graduate of Kalamazoo College, Chicago University, and is taking a post-graduate course in University of Michigan. He has had a great deal of practical work in his line during his college course.

Mr. A. G. Wessling, of the Bullock Electric Manufacturing Co., of Cincinnati, O. (the Electrical Department of the Allis-Chalmers Co., of Milwaukee), has recently delivered a lecture on "Methods of Control for Variable Speed Motors," at the following institutions: Cornell, Lehigh, Columbia, Harvard, Massachusetts Institute of Technology, Ann Arbor, Purdue, University of Illinois and Rose Polytechnic Institute.

Mr. Ernest McCullough has resigned his position as Engineer for the Municipal Engineering & Contracting Co. of Chicago, and possibly will open an office for private practice in Chicago, making a specialty of concrete work. Since the above company last year stopped contracting to manufacture trenching machinery and concrete mixers Mr. McCullough has been in charge of the advertising and sales department of the Chicago Improved Cube Concrete Mixer.

Mr. Ray S. Carberry, of Illinois, has been appointed Assistant Engineer in the U. S. Reclamation Service, and will report for duty to Mr. S. G. Porter, at Mitchell, Neb. Mr. Carberry is a graduate of the Engineering Department, University of Illinois, and has been engaged on the construction of public works in Illinois; as General Manager, Marysville Canal & Improvement Co., Idaho; with the Oregon Short Line R. R. Co., Idaho, and with the Wabash R. R. Co.

Mr. J. O. Burrage, Jun., Am. Soc. C. E., of California, has been appointed Assistant Engineer in the U. S. Reclamation Service and assigned to duty under Engineer J. E. Field, Denver, Colo. Mr. Burrage was graduated from Tufts College, and worked on location of canals and locks, Merrimac River, Lowell, Mass.; for the American Ordinance Co., Bridgeport, Conn., on location of property lines; for the Union Iron Works, San Francisco, Cal., and on the Board of Public Works, San Francisco.

Mr. C. E. Grunsky, M. Am. Soc. C. E., Consulting Engineer U. S. Reclamation Service, has gone on an extended trip through the Northwest. As personal advisor of the Director of the Geological Survey, Mr. Grunsky will devote considerable time in Montana in careful investigation of the somewhat delicate international questions involved in the Government's irrigation project in the Milk River Valley. Later he will proceed southward, visiting in turn several projects in Wyoming, Colorado, New Mexico and Utah.

Mr. Ray S. Blinn, of Ohio, has been appointed Assistant Engineer in the U. S. Reclamation Service, and directed to report for duty to Mr. Sam G. Porter, Mitchell, Neb. Mr. Blinn was graduated from the Ohio State University with the degree of C. E., and from 1894 to 1901 was engaged in various engineering capacities for private parties and railroad companies. In 1902 he became Resident Engineer in charge of construction for the B. R. & P. Ry. Co. in Pennsylvania, and in 1903 became connected with the El Paso & S. E. Ry. as Locating Engineer.

Mr. Arthur B. Dodd, of California, has been appointed Assistant Engineer in the U. S. Reclamation Service, and will report for duty to Mr. Andrew Weiss, Ft. Laramie, Wyo. Mr. Dodd is a graduate of Purdue University, Lafayette, Ind., with the degree of C. E., and has held various positions on railroad and state works in the state. He also had charge of a party making surveys for hydro-concessions for the Canadian Government in Yukon Territory. Has held commission as Hydrographic Surveyor in the U. S. Navy and with the Western Pacific Ry.

Mr. Archer Richards, recently Chief Draftsman for the Wason Car Co., of Springfield, Mass., has resigned to accept a position as Chief Draftsman for The Roberts & Abbott Company, Engineers, of Cleveland, O. Mr. Richards was with the Wason Manufacturing Co. six years and with the Jackson & Sharp plant of the American Car & Foundry Co. for 14 years. He was also in the Engineers' office of the Chicago, Milwaukee & St. Paul Ry. in the department of bridges and buildings. Prior to that time he was with the Enterprise Hydraulic Works of Philadelphia, and afterwards Chief Examiner of drawings of structural steel work in the Edgemoor Iron Works, Wilmington, Del.

Obituary.

L. H. Sutton, of Kansas City, Mo., a retired contractor, was killed April 28 in a runaway accident. He had been in the building contracting business for 19 years.

Samuel P. Hermany, a civil engineer in the employ of the Louisville Water Co., of Louisville, Ky., died on April 23, at his home in that city. He was the son of Charles Hermany, Chief Engineer of the Louisville Water Co.

Marcus H. Thorn, a mining engineer of California, was killed last month in a mine accident in Corea. He was a brother of Joseph F. Thorn, Superintendent of the Tabowie and Taracol mines of the Oriental Consolidated Mining Co., in Corea.

M. O. Johnson, Supervising Architect of the Isthmian Canal Commission, died April 30 at Ancon Hospital, Canal Zone, of yellow fever. He was formerly employed as Architect by the Illinois Central R. R., and was appointed Chief Architect to the Canal Commission on the recommendation of Chief Engineer Wallace, under whom he had served. His work included the designing of new buildings needed along the route of the canal and the repairs for the old buildings. He had been on the isthmus since last July. Mr. Johnson was a native of Kentucky and was 28 years old.

ENGINEERING SOCIETIES.

COMING MEETINGS.

INTERNATIONAL RAILWAY CONGRESS.
May 3 to 15, 1905, at Washington, D. C. Secy. of American Committee, W. F. Allen, 24 Park Place, New York.

AMERICAN WATER-WORKS ASSOCIATION.
May 8 to 12, 1905. Annual meeting at Wabash, Ind. Secy., J. M. Diven, Charleston, S. C.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.
May 16, 1905. Annual meeting at New York.

ASSOCIATION OF RAILWAY TELEGRAPH SUPERINTENDENTS.
May 17, 18. Annual meeting, at Chattanooga, Tenn. Secy., P. W. Drew, Wisconsin Central Ry., Milwaukee, Wis.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
June 6, 7, 8, 9, 1905. Annual spring convention at Scranton, Pa. Secy., F. R. Hutton, 12 West 31st St., New York, N. Y.

AMERICAN FOUNDRYMEN'S ASSOCIATION.
June 6 to 9, 1905. Annual convention in New York. Secy., Richard Moldenke, Watchung, N. J.

MASTER CAR BUILDERS' ASSOCIATION.
AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.
June 14-21, 1905. Annual meeting at Manhattan Beach, N. Y. Secy., J. W. Taylor, The Rookery, Chicago, Ill.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.
June 19 to 23, 1905. Annual Convention at Asheville, N. C. Secy., R. W. Pope, 95 Liberty St., New York, N. Y.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
June 20 to 23. Annual convention at Cleveland, Ohio. Secy., Charles Warren Hunt, 220 West 57th St., New York, N. Y.

LEAGUE OF AMERICAN MUNICIPALITIES.
August 23 to 25. Annual meeting at Toledo, O. Secy., J. McVicar, Des Moines, Ia.

ROADMASTERS & MAINTENANCE OF WAY ASSOCIATION.
Sept. 12, 14. Annual meeting, at Niagara Falls, N. Y. Secy., C. E. Jones, C., B. & Q. Ry., Beardstown, Ill.

ENGINEERS' CLUB OF PHILADELPHIA.—Two papers will be presented at the club's meeting of Saturday, May 6: "Recent Developments in Expanding Machinery," by Mr. L. D. Lovekin, and "Stereoscopic Vision Applied to Surveying," by Mr. E. F. Northrup.

GOOD ROADS CONFERENCE.—A Good Roads Conference has been called for May 16 to 19 at the College of Agriculture, Cornell University, Ithaca, N. Y. Prof. L. H. Bailey, Director of the college, is in charge, and may be addressed for further information.

BROOKLYN ENGINEERS' CLUB.—The May meeting of the club will be held at its rooms, 197 Montague St., Brooklyn, N. Y., on the evening of Thursday, May 11, 1905. Mr. James C. Meem will read a paper on "Some Recent Methods of Tunneling in Soft Ground," which will be illustrated with lantern views.

INTERNATIONAL PETROLEUM CONGRESS.—In connection with the Liege (Belgium) International Exhibition to be held this summer, the Second International Petroleum Congress will meet at Liege, during the period June 26 to July 1, 1905. Mr. L. Dejardin is President and Mr. F. Petit (95 Chaussee de Wavre, Brussels, Belgium), is Secretary of the congress. The congress will meet in four sections, dealing respectively with 1, Geology, Exploration and Exploitation; 2, Chemistry and Industrial Treatment; 3, Utilization of Petroleum and its Derivatives; and 4, Legislation. Membership in the Congress involves a subscription of 25 francs, while the title of Donor may be held on payment of 100 francs or more.

INSTITUTION OF CIVIL ENGINEERS (GREAT BRITAIN).—At the annual meeting, held at London, England, on the evening of Tuesday, April 18, the following officers were elected for the coming year: President, Sir Alexander Binnie; Vice-Presidents, Messrs. A. B. W. Kennedy, W. R. Galbraith, W. Matthews and Sir Leader Williams; Councillors, Col. W. P. Anderson (Ottawa, Can.), Mr. C. N. Bell (Wellington, New Zealand), Messrs. B. H. Blyth, C. A. Brereton, R. Elliott-Cooper, Col. R. E. B. Crompton, W. V. Cudworth, G. F. Deacon, F. Elgar, M. Fitzmaurice, R. A. Hadfield, G. H. Hill, C. W. Hodson, J. C. Inglis, G. R. Jebb, Sir Wm. G. Lewis (Cape Town, Africa), Sir Andrew Noble, C. A. Parsons, A. Ross, A. Siemens, J. Strain, Sir John I. Thornycroft, Prof. W. C. Unwin, and A. F. Yarrow.

AMERICAN SOCIETY OF CIVIL ENGINEERS.—It is reported from Kansas City, Mo., that on April 8 the Kansas City Association of Members of the American Society of Civil Engineers was organized at a meeting of some fifteen members. The association is planned to include all the members of the society living in or near Kansas City, and to hold periodic meetings for social and professional purposes. Mr. D. Bontecue was elected President, Messrs. I. G. Hedrick and S. W. Fox Vice-Presidents, and Mr. C. D. Burns Secretary. A meeting of similar purpose was held on April 13 at Washington, D. C., at which the subject of forming a local organization of members of the Society was discussed, but without reaching a conclusion. Gen'l Alexander Mackenzie, of the Corps of Engineers, presided, and Mr. H. M. Wilson, of the U. S. Geological Survey, acted as secretary.